1914

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 52.

MINERAL RESOURCES

THE NORTH-WEST DIVISION.

INVESTIGATIONS IN 1912.

ву

T. BLATCHFORD, B.A.,
ASSISTANT GEOLOGIST.

With an Appendix by E. Davenport Clelan I, Inspector of Mines.

Issued under the Authority of the Hon. P. Collier, M.L.A.,
Minister for Mines.

WITH TEN PLATES AND FORTY FIGURES.



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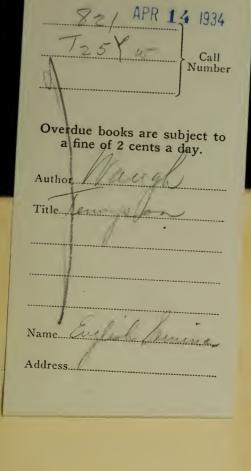
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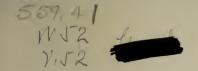


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PREFATORY NOTE.

This Bulletin is the fourth of the series dealing with the geology, mineral resources and condition of mining in the North-West Division.

The purpose of this series, which includes Bulletins 33, 40, and 41, is to furnish an authentic account of the economic results of the investigations into the mineral wealth of the North-West during recent years.

This Bulletin contains, in addition to other matter, an important report on the geological relationships of the Asbestos Deposits of Soanesville, the mining of asbestos and its preparation for the market.

The concluding portion of Mr. Blatchford's report embodies certain suggestions with regard to the methods by which prospecting may be encouraged in those portions of the district through which his investigations led him. Adequate provision exists under the terms of the Mining Development Act for giving effect to any of the suggestions put forward, with the possible exception of that involving advances against the sale of copper and tin ore, for which arrangements have now been made.

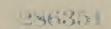
To Mr. Blatchford's report there has been added that prepared, in 1909, by Mr. E. Davenport Cleland, Inspector of Mines, with the object of bringing the whole of the recent official literature on the North-West into one handy form for convenience of reference by those interested in the resources of the district.

The results of the later investigations amply bear out the view previously enunciated in Bulletin 40, that if both prospecting and mining operations are carried out with due regard to the prevailing geological conditions, the North-West will continue to be a mineral producer.

A Gibb Warland

GOVERNMENT GEOLOGIST.

Geological Survey Office, Perth, 14th January, 1913.



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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA.

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Mineral Resources of the North-West.

Report on Investigations in 1912.

In accordance with official verbal instructions I proceeded to the Pilbara and West Pilbara Goldfields to report on the following subjects:—

IN THE PILBARA GOLDFIELD.

- (1.) The Question of the erection of a State Battery at Bamboo Creek.
- (2.) The Proposal to erect a State Battery at the new tin discoveries at Wodgina.
- (3.) The Occurrence of Asbestos in the vicinity of Cooglegong.
- (4.) The Question of a water supply for the privately owned Eastern Creek Battery.

IN THE ROEBOURNE DISTRICT.

- (5.) Gold and Copper Mine held by Mr. Smallpage, more particularly as regards a Concentrating Plant.
- (6.) The Question of how to advance the Copper Industry in the Roebourne district, and
- (7.) In general to investigate the existing conditions as a whole, with the object of making suggestions as to how the mining industry in the North-West could be best assisted.

In addition, I received whilst in the field, telegraphic instructions to see the owners of the Portaminna G.M., and to go into the questions as to whether any royalty, in connection with the treatment of sands on their mine, claimed by the Department of Mines, should be insisted upon. Later on I was further instructed to visit the Uaroo Lead and Silver Mine and report on the same.

The time occupied in performing this work extended from April 8th, the day I arrived at Marble Bar, to July 8th, the day of my arrival at Onslow. Considerable delay was caused in reaching Marble Bar on account of the hurricane, which wrecked the s.s. "Koombana," washing away part of the Port Hedland-Marble Bar railway line, and another delay at the Onslow end was caused by a boat omitting to make it a port of call, necessitating a week's wait for the next.

During the three months 1,200 miles were covered in a buggy and about 200 miles on horseback. As a rule, the roads were bad and heavy in the Pilbara Field, on account of the heavy rains; while in the Ashburton District the country was drought stricken, and it was impossible to leave the track to visit several places which warranted inspection.

As the geological features of the country traversed have already been dealt with extensively in a report by the Government Geologist,* and, in some instances, by the State Mining Engineer in an Appendix to the same report, but, as my mission was in connection with economic, rather than stratigraphical geology—questions affecting those centres—little, if any, geological survey work was carried out during the trip. I made a point, however, of visiting any mines, were particularly any isolated ones, that were being worked, and so endeavoured to gain some general idea of the mining possibilities and prospects of the various mining centres which came under my notice.

A series of short reports on the different mining centres through which I passed, with a description of the mines then being worked, dealing more particularly with the subjects and localities already enumerated, are attached hereto.

On arriving at Marble Bar and ascertaining that, owing to the stoppage in telegraphic communication, transport was unobtainable, I availed myself of the opportunity of going to Eastern Creek via Nullagine, with Warden Riches, who was due at these centres on official duties.

The country between Marble Bar and Nullagine has already been exhaustively examined and reported upon geologically by the Government Geologist,[†] as has also the Nullagine centre.

NULLAGINE.

At the date of my arrival at Nullagine there were but three prospectors fessicking in the conglomerates for the richer portions of this extensive auriferous deposit. The rich alluvial patches have either been worked out or still defy detection.

Judging from what could be seen of the abandoned workings in the conglomerates, it appears that little, if any, legitimate development work has ever been done to prove the extent and gold contents of these deposits, and such still remain to be determined. That a considerable amount of capital has been spent in development is evident, but apparently with little, if any, system, and certainly

^{*} Bulletin 40, being Reprints of Bulletins 15, 20, and 23.
† Vide Bulletin 40

prospecting has not yet been carried far enough to condemn this hage anriferous belt as annayable. Unfortunately, the Nullagine conglomerates seem to be of that class of low grade formations which need the aid of the best mining practice and adequate working



capital to give them any reasonable hope of success, and the mere fact of one company closing the proposition down makes it doubly difficult to obtain sufficient capital to re-open it.

Judging from the opinions of previous writers, and from what I could glean on the spot, the gold is not evenly distributed through-

Photo: T. Blatchford.

out the conglomerates, and is of secondary origin, but taking into consideration the amount which has been won from the sheddings



in the gullies and from the treatment of the conglomerates themselves, there can be no doubt but that large tonnages of payable

'ig. 2.

ore will be found in the future, however distant that future may be. More will be written at the end of this report on the possible ways in which attempts in endeavouring to attain this object in this and other centres could reasonably be assisted.

Full data on the Nullagine centre can be found in the Government Geologist's Report * and the State Mining Engineer's Appendix, † and to which reference should be made.

EASTERN CREEK.

From Nullagine we journeyed to Eastern Creek, ‡ a distance of some 45 miles in a north-easterly direction, passing en route the Barton Mine, Mosquito Creek, and 20-Mile Sandy. Mosquito Creek mining centre was completely deserted, and the Barton Mine shut down, though the stoppage will doubtless be of a temporary nature. At Eastern Creek there was a certain amount of prospecting being carried on by a few prospectors who were working the rich, short quartz lodes which are the prevailing type of ore bodies in this centre.

Unfortunately, owing to the lack of water, for some considerable time previous to my visit crushing facilities had been at a standstill. This had hindered the prospectors very considerably, for it was impossible to profitably cart their stone to the mill at 20-Mile Sandy. Owing to the late rains, however, sufficient water was obtainable from a well to run a 10-head mill for some cousiderable time to come. As regards the question of permanent water for this (Doherty's) battery, the facts are these: There are two wells in close proximity to the battery, one with a vertical depth of 80 feet, the property of the battery owners, and the other a Government one with a vertical depth of 140 feet. The supply in either is inadequate for battery purposes during the summer months unless the season is an exceptionally wet one. It seems, therefore, inadvisable to sink the private well to greater depths in the hope of getting a permanent supply. The battery site is not a particularly good one, and one three miles away on Cook's Creek would be practically as suitable for present needs. At Cook's Creek site there is a permanent water-hole and a good bottom on the banks of the creek for foundation blocks, etc., for a battery. To shift the battery to this site would be, in my opinion, cheaper and more economical than trying to locate uncertain water supplies in wells at the present site. If such a course be adopted, I would strongly recommend the battery owners not to remove their present boilers and engine to the new site, but rather strain every effort to instal an internal combustion engine there, and set off the saving in transportation and erection of the old against the initial cost of the new engine. The saving in the cost for power would soon recompense them for the extra outlay.

Bulletin 40, pp. 114, et seq. † Bulletin 40, pp. 399, et seq.
 † Vide Map. Plate X.

Taken as a whole the mines at Eastern Creek are in the first stage of development. At present the only forms of ore bodies



Fig. 3.

being worked are short shoots of quartz, which are invariably lenticular in shape.

Neg. 873.

Conglomerates at Eastern Creek.

Photo: T. Flatchford.

Photo: T. Blatchford.

From cursory observations it would appear that the country rock belongs to the Mosquito Creek Series, and consists of the typical quartzites, altered sandstones, etc., with interbedded conglemerates, the beds lying at a high angle from the horizontal. These beds have been twisted, bent and faulted in ail directions,



and it is in the folds that the quartz has been deposited. The reefs can be roughly likened to vertical saddles as shown in the accompanying diagram of the Crescent G.M. (Plate I.). It necessarily follows that prospecting should be carried on not only vertically, but that cross-cuts should be put in horizontally at the tops of the folds,

i.e., where the quartz is thickest. I consider that such development would be certain to reveal fresh reefs or saddles. That the saddle formation is the occurrence of the quartz reefs can be seen in some instances from the outcrops, but, owing to the broken nature of the surface, these are more often covered over by surface debris.

The Crescent G.M.L. 180L.—This mine lies about half-way between the battery and Cook's Creek. It is situated on the top of a rough hill, the ore from the mine being removed to the track on the level ground by means of a "flying fox" rigged on a light steel rope (see Fig. 37.) The workings consist of an open-cut as seen on the accompanying sketch plan, Plate I., and a shaft on the underlay carried to a depth of 60 feet. Though the returns from ore raised are high in gold values, the stone is small and short. Under the existing conditions low-grade ore is worthless, the handling, cartage, and crushing costs being of necessity very high. In a gully at the foot of the hill a quartz reef was worked, but eventually it became too small to follow and was abandoned.

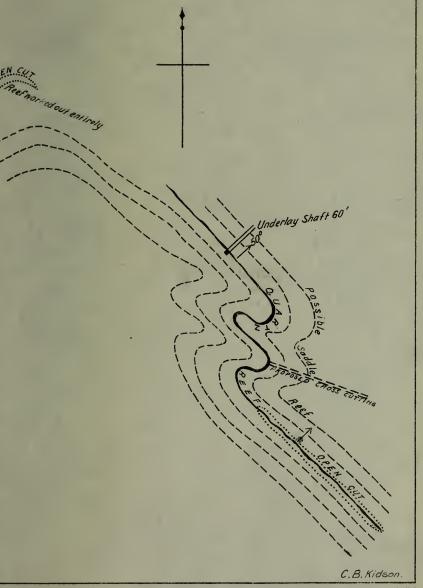
The Reward G.M.—On this property are two parallel reefs, about two chains apart, with a general direction of N. 40 deg. east, and underlies to the east at a high angle. The reefs form a kind of half circle. At the northern end they intersect a band of conglomerate, and turning to the eastward follow this course for a short distance and then disappear beneath the surface. The ore crushed has been taken from the scattered out-crops and from a few feet only below the surface. The width of the ore is variable, but averages from three to five feet.

The Morning Star G.M.L. 182L.—The reef worked on this mine is apparently a continuation of the eastern reef of the Reward Mine. Very little prospecting has been done on this property, but the stone won from the surface has given payable results. A band of conglomerate cuts through the northern end of this lease. There are several other prospecting properties and a fair number of quartz bodies still untouched, but these are all small quartz veins. I saw nothing during my short visit in the way of an ore deposit which might be called massive.

Table showing the Yield of the Eastern Creek Reefs.

Name and No of Lease.	Dollied.	Tons crushed.	Gold therefrom.
	fine ozs.	tons (2,240lbs.)	fine ozs.
The Crescent (180L)	1	631 · 75	1,064 · 41
Doherty Reward (176L)		142 · 25	171.43
Doherty Reward Leases (176L, 177L)	1	17.00	$428 \cdot 79$
The Harp (177L)		$62 \cdot 00$	$79 \cdot 22$
The Morning Star (182L)		233.00	425.93
The Olive (187L)		20.00	18.76
The Rose (179L)	1	152.00	83.00
The Shamrock (178L)	4.00	206 · 25	$319 \cdot 30$
The Thistle (184L)		33.50	$33 \cdot 02$
Sundry Claims	3.77	10.00	16.31
Total (to 31st December, 1911)	7.77	1,507 · 75	2,640 · 17

PLAN OF THE CRESCENT G.M. EASTERN CREEK, PILBARA G. F.





THE BARTON GOLD MINE.

On the return trip from Eastern Creek to Nullagine, I called in and inspected *The Barton G.M.* At the time of the State Mining Engineer's visit in 1907 the water shaft had been sunk to a vertical



depth of 160 feet, and a drive commenced to the south in the ore channel. Since that date the drive has been extended for a total distance of 350 feet. The lode in this level consists of two parallel quartz reefs, separated by a band of decomposed rock, about six to

Fig. 5.

eight feet in thickness. So far the work has been practically done on the hanging wall reef.

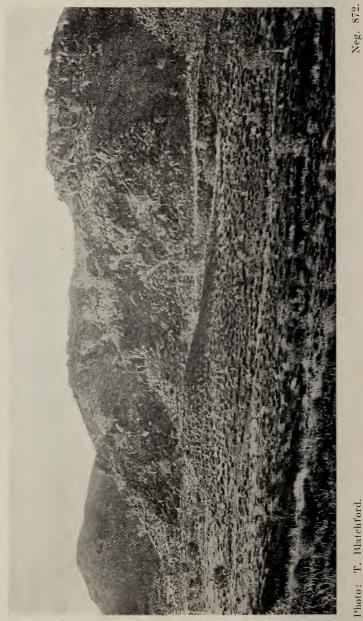


Fig. 6.

At a distance along the drive of 150 feet, the stone has been stoped for 200 feet to the 100 feet level. The average width of the

Country between Eastern Creek and Nullagine.

Photo: T. Blatchford.

reef in this stope was about 2 feet 6 inches. So far the foot-wall reef has not been broken, for it is of much lower grade in gold



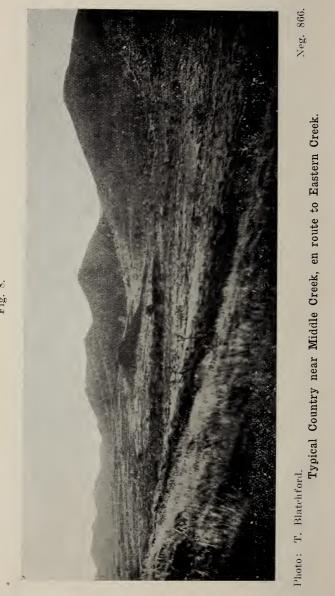
Photo: T. Blatchford.

Typical Country near Middle Creek, en route to Eastern Creek.

Neg. 869.

contents than the hanging-wall reef. At a distance of 200 feet south of the shaft in the 150 feet level, a winze has been sunk to

a vertical depth of 26 feet, showing the continuance of the hanging wall reef for that depth, with an average width of one foot six



inches and a value per ton of 21 dwts. In the north end of the drive, adjacent to the water shaft, the reefs are broken, and go off

in stringers of quartz, but as the reef is seen at the surface outcropping further north this splitting up is probably only temporary.

The average value for the stone crushed from the 150ft. to 100ft. level has been about 36 dwts. per ton. On the surface the main reef can be followed for a distance of at least 1,200 feet. A short distance to the east of the main reef and running parallel to it, is another bold outcrop, which, up to the present time, has not been developed, though it undoubtedly carries gold values. In Bulletin 40, pp. 92, et seq., the Government Geologist has written up the details of the earlier workings and history of this mine, and a further complete report is supplied by the State Mining Engineer in the same Bulletin, and will be found on page 95 of the appendix. I concur with these writers that the adjoining outcrops on the Barton Gold Mine are the most persistent and permanent in appearance of any of the quartz reefs in the Nullagine District.

After inspecting the Barton Mine, we pushed back to Marble Bar, and from thence, with a fresh outfit of horses, and a departmental trap, I proceeded to Bamboo Creek, which lies in a northeasterly direction from Marble Bar at a distance of approximately 50 miles.

En route the Moolyella tinfields were visited, but there is little to record about this centre. At the time of inspection there were some half-dozen prospectors dry-blowing the old worked-out gullies for tin (oxide), and a few natives with their gins doing the same class of mining. At the upper end of the workings, some narrow pegmatite veins have been opened out to a very small extent, but sufficiently to show the tin oxide in the dykes. It is probably to the denudation of such dykes and some of the associated massive granite in this district that the tin leads owe their origin. Sluicing and puddling the tailings in the gullies has been resorted to, but without much success.

BAMBOO CREEK.

In 1904 a Geological report* and map was issued by the Government Geologist on the Bamboo Creek Mining centre with a description of the various mines then in operation and notes from the reports of Messrs. S. J. Becher and R. G. Gladstone, Inspectors of Mines for the District, on some of the mines now abandoned and inaccessible for inspection.

During 1911 a report was sent in to the Department by Warden Riches on the question of subsidising crushing, carting, water supply, etc.

Since 1904 and more particularly during the last few months certain prospecting and development work has been done on some of the mines which has an important bearing on the future of the

^{*}G.S. W.A., Bulletin No. 15, also Bulletin No. 40,

district, and the following report will be confined to a description of these developments and their possibilities, with a few remarks on the present conditions of the field with regard to crushing facilities, water supply, etc.



Fig.

There is unfortunately no further available information to be gathered about most of the mines than that already supplied by the Government Geologist's report of 1904.

Starting on the western end of the belt, the first important development is in the Prophecy mine.

The Prophecy Mine.—The mine was worked by the Mount Prophecy and Perseverance Gold Mining Company, the principal



Coppin's Gap, near Bamboo Creek (North of Fig. 9).

work carried out being by two adits into the hill to try to cut the reef which has been worked from the outcrop to a vertical depth of

about 90 to 100 feet. The top adit intersected the reef at a longitudinal distance of 86 feet and a winze sunk on the underlay proved the non-existence of the reef, though the ore channel was distinct. was picked up in an adit 140 feet lower down and at a horizontal distance from the surface of 250 feet; no driving was done in this ore channel either east or west, though vertically overhead at the surface it was evident that these workings were at the eastern end of the quartz outcrop. On the abandonment of the lease by the Company, work was continued in the lower tunnel by private enterprise, and what I consider to be a fresh reef has been cut at the end of the tunnel, a horizontal distance from the surface of 305 feet. Though this reef is small, being only a few inches thick, it is rich in gold, and I consider it to be a parallel reef to the one formerly worked in the upper levels. This development is important, as it proves that high grade ore exists at a vertical depth of over 200 feet from the surface; it also proves the occurrence of parallel ore bodies.

Bamboo Queen G.M.L. 733 (formerly G.M.L's 54 and 409).—A three-compartment timbered shaft, 210 to 230 feet vertical depth, was sunk on this mine by the previous holders of the ground, but owing to the late heavy rains the lower workings were flooded and inaccessible. The owners of the mine assured me that the following development work had been carried out by them at the 176 feet level. Crosscut N.E. 75 feet and S.W. 75 feet, and a drive 45 feet N.W. In this development work several quartz veins were cut. but were not payable. As in the Prophecy G.M., the shaft has been sunk on the S.E. end of the quartz reef, which had been worked in the upper levels; the present owners intend continuing the drive further to the north-west. At the 100 feet level a crosscut has been put in 40 feet north-east opposite the shaft, and drives extended from the shaft 30 feet north-west and 35 feet south-east. From the shaft for a distance of 30 feet into the crosscut the country is much crushed and impregnated with quartz leaders. A trial parcel of 100 tons from the drives and crosscut gave a return of six dwts. over the battery plates. The value of the tailings is unknown. Above the 100 feet level practically all the stone has been stoped, the returns from which may be seen in the Government Geologist's report for 1904.* I consider that further prospecting at the 100 feet level in this mine and probably at the 160 feet level will disclose considerable quantities of low grade ore.

Bonnie Doon G.M.L. 408.—As can be seen from the report of the Government Geologist for 1904, the ore body in this mine is much larger than the average quartz vein of the Bamboo District. The main shaft has at present a vertical depth of 100 feet, with two timbered compartments: a winze has been sunk 30 feet below this level. Stoping from the level upwards produced 1,000 tons of ore

^{*} G. S. Bulletin No. 15, also Bulletin 40.

with a return of about £3 per ton over the plates. West of the shaft the quartz is intact, and is from 4 to 8 feet thick. At present the workings are unsafe, but with a small capital outlay the stone could be cheaply mined. In the eastern end of the stope, the stone is smaller, but is considered payable. With anything like reasonable carting and crushing charges there are many hundred tons of ore above the 100 feet level in this mine, which would give a handsome profit. I have every reason to believe that the reason why mining operations were stopped in this mine was due to the fact of the heavy crushing and carting charges, about 50s. per ton. The upper workings of the mine and gold returns have been referred to fully in the Government Geologist's report, 1904. While sinking the shaft, the manager assured me that they drew from 5,000 to 7,000 gallons of water per hour. I have every reason to believe this statement.

Bamboo King G.M.L. 471 ("Micky").—A brief description of this mine is to be found in the report of 1904. The workings at present are unsafe, but I was able to see that there was a considerable quantity of stone left in the stopes. At the mouth of the tunnel 120 tons is still at grass; 56 tons from the heap yielded 11dwts, per ton over the plates, a return which paid crushing and carting charges only.

Kitchener G.M.L. 707.—Since the top levels were stoped considerable prospecting has been done by the present owners. There is a vertical shaft timbered to 100 feet and equipped with a boiler and pump. At the 100 feet level a crosscut has been put in south-west for a distance of 70 feet from the shaft. At the end of the crosscut drives extend 30 feet north-east and 30 feet south-west, exposing a reef for the whole distance. This is a parallel reef to the one worked on the surface. Stone is showing in the face of the drives and underfoot. There are some 40 feet of backs to be stoped above this level. The last crushing averaged six ounces over the plates and gave a return of some £1,300 sterling. The gold in this reef is usually found with traces of galena. I consider this another example of a mine resuscitated by plucky prospecting and a demonstration that though the outcropping ore bodies may cut out, other payable paral-

Bonnie Dundee G.M.L. 712.—This and another prospecting claim, known as Grant's, occurs some two miles south of the Bonnie Doon. On both properties outcrops are seen running practically east and west and up till recently were neglected, being regarded as "cross courses." The prospectors on the Dundee, however, have sunk a shaft to a vertical depth of 18 feet. Stone taken from these workings gives pan prospects sufficiently encouraging for them to continue their work, provided reasonable crushing facilities are obtainable. On the surface the quartz outcrop can be traced distinctly for at least half a mile. The reef on Grant's claim runs parallel to that on the Bonnie Dundee. Prospecting has only just been commenced on this reef.

lel ore bodies may still be found.

Revenue G.M.L. 718.—Flat leaders have been worked on this mine from which, by dollying, 251 ounces of gold have been recorded. A quartz outcrop extends east and west across the lease, but so far has not been exploited.

Bulletin G.M.L. 695.—This mine is flooded with water and is inaccessible.

Crushing Facilities, Water, Timber, etc.—The battery charges at the Bulletin G.M., the only crushing plant at Bamboo, are £2 per ton, and the average cost for carting, including labour, about 12s. 6d. per ton. The water supply is inadequate. The mill was originally working ten head, but at present five head are in absolute decay, and the five head in use are in a bad state of repair, and provided with only five feet of plates. crushing purposes the site is unsuitable, as it is at least three miles distance by road from the principal mines. As a public mill it renders it necessary for the prospector to obtain at least twenty pennyweight ore to pay expenses;—I consider that if the charges for crushing reduced to those prevailing the Marble were at State Battery there would immediately be available sufficient to keep a five-head mill running constantly two shifts a day for twelve months, and that it would be highly probable that the mines not only now working, but many of those long since abandoned would be taken up and developed. There were at the time of my visit seventeen men working on the field, mostly on development work. With regard to the question of subsidising the present mill, or defraying the carting charges of stone to the same, I cannot see how it would materially benefit the mining community of Bamboo Creek. To put the present Bulletin mill in good working order would be a costly undertaking, as it would practically have to be reconstructed and an internal combustion engine added to replace the present steam plant. As has already been pointed out, the position is unsuitable and the water supply is limited and insufficient.

The cost of fuel delivered is £3 per cord, and charcoal can be obtained probably for between £7 to £8 per ton.

As has been pointed out, there is a copious supply of water on the Bonnie Doon, and the owners of this mine are agreeable to hand over the use of one of the compartments of their shaft indefinitely as a pumping shaft. Although it may not be desirable to obtain water for public purposes from a private source, I see no objection when the owners are willing to be bound down by agreement. The site is central and suitable for battery purposes, and the Engineer for Mines Water Supply assures me that there would be no difficulty in obtaining another water supply if necessary in the immediate vicinity. Freight from Marble Bar to Bamboo Creek can be reckoned at £3 per ton for material easily handled, and £4

10s, per ton for machinery. The ore at Bamboo Creek is apparently free milling and amenable to cyaniding. The stone is quartz, with a little, if any, lode material.

After a personal examination and consideration of all the evidence, I am of opinion that a State mill is warranted and necessary at Bamboo Creek, and that there is enough stone raised or ready for stoping to keep a small mill going, also that the erection of a State mill would encourage prospecting in the district and be the means of opening up again several mines at present abandoned.

I am also of the opinion that unless something definite be done in this direction at an early date, with perhaps the exception of three mines, the field will be abandoned.

Table showing the Yield of the Bamboo Reefs up to the end of 1911.

Name and Number of I ease.	Ore Crushed.	Gold therefrom.
ALL CMI (997)	tons.	fine ozs.
Alpha G.M.L. (395)	4.00	7.44
Bamboo Consolidated G.M. Co., G.M.L. 161/193	1,579 · 50	2,995.85
Bamboo Queen and Reward Mines, Ltd., G.M.Ls (409, 547)	1,390.50	1,935 · 20
Bamboo Revenue, G.M.L. 719 *		
Blue Streak, G.M.L. (709) †		
Bobby Burns, G.M.L. (693)	1.50	$23 \cdot 67$
Bulletin, G.M.L. (161)	$1,965 \cdot 00$	$3,427 \cdot 92$
Bulletin G.M.L. (161)	$82 \cdot 00$	$279 \cdot 47$
Bulletin, G.M.L. 695	$322 \cdot 00$	$722 \cdot 42$
Bulletin Leases, G.M.L.s (161, 653)	$440 \cdot 00$	$1,104 \cdot 97$
Federation, G.M.L. (462)	$34 \cdot 50$	$44 \cdot 63$
Mt. Prophecy, G.M.L. (46)	$318 \cdot 50$	$559 \cdot 68$
Mt. Prophecy and Perseverance G.Ms., Ltd., G.M.Ls. (46, 49)	$1,339 \cdot 50$	$2,563 \cdot 14$
Nil Desperandum G.M.L. 119	169.00	126 - 67
Pilbara Goldfields, Ltd., G.M.Ls. (62, 76, 406, 407, 408, 471)	$2,297\cdot 75$	2,663.46
Pilbara Syndicate, Ltd., G.M.L. 171	96.00	98.61
Premier G.M.L. (432)	40.00	68.95
Tasmanian and No. 1 Timbuctoo, G.M.L. (71, 187)	1,433.00	$2,681 \cdot 87$
Tidal Wave G.M.L. (522)	80.00	$68 \cdot 85$
Sundry Claims ‡	$148 \cdot 75$	$518 \cdot 36$
Total	11,741 · 50	19,891 · 16

^{527.86 ,,}

NORTH POLE.

On completing the inspection of the Bamboo Creek mines I returned again to Marble Bar, and from thence made my way to the "North Pole," by way of Boyer's track. The road was exceptionally rough and in places unfit for vehicular traffic. As a matter of fact, towards the end of the journey we resorted to pack and saddle horses.

From both a geological and mining point of view this journey was well worth the trouble, as the North Pole is a most interesting centre for both studies.

The North Pole itself is situated to the immediate west of a boss of granite about 10 to 12 miles long by 5 to 7 miles wide, which has at some time forced its way through the greenstone. The greenstones themselves are surrounded in their turn by steep rugged ranges of the Nullagine Series. As these rocks are described in full in *Bulletin* 40, reference to the mines and lodes only will be made in this report.

The Percy Mine is situated about 30 chains south of the most eastern peg of the old Democrat lease, which has been fully described in Bulletin 40, page 38. On the Percy a fairly well-developed copper lode has been opened out to a vertical depth of 60 feet. At the bottom of the shaft two short drives have been put in on the course of the lode, which has a bearing of N. 35deg, to 40deg, W. The lode underlies north-east at a high angle. In the face of the northwestern drive the lode has a width of some 16 feet, and in this face six feet at present is of a payable nature, a sample I broke out myself giving the return of 11.18 per cent. of metallic copper, with gold contents nil. Both to the north and south of the shaft the lode may be seen outcropping on the surface. Some fine specimens of green carbonates were picked up from these outcrops. It was interesting to note that these green carbonates had the crystalline form of the blue carbonates of copper, and were probably pseudomorphs by replacement after such.

Ten tons of copper ore taken from this mine and shipped to Port Kembla, N.S.W., gave a return of 16 per cent. metallic copper, gold nil.

Besides the old workings described in *Bulletin* 40, and now abandoned, there are numerous quartz reefs throughout this area which have so far not been touched. Travelling about seven miles south-east from North Pole to a spot about ten miles distant from Shady Well some very interesting country was traversed. Here the hills are extremely rugged, the country rock being represented chiefly

by much altered sediments, now standing up in rugged peaks of quartzite, through which the water-courses have cut deep gorges.

At a spot known as "Breen's Camp" there is a magnificent example of the formation of a mineral deposit on an enormous scale. This consists of a lode of barytes (barium sulphate), which assumes the dimensions of a range rather than a typical ore deposit; but it clearly shows that the lodes of this district need not be small and insignificant, for if thousands of tons of barytes can be formed as it occurs here, why not the same quantities of other minerals of a higher commercial value? It is certainly encouraging in this respect.

Immediately below this barytes range, and at the end of a gorge cut through it is a fine water-hole. It is said that when this water is used for drinking purposes the consumer has difficulty in appearing his appetite, the water acting as a powerful tonic.

The Mineral Industry for 1910 gives the following information on the commercial use of barytes:—

The business is small, the total consumption of barytes not usually exceeding 55,000 tons annually. Between 12,000 and 15,000 tons of crude material are imported (i.e., into U.S.A.) each year containing 95 to 96 per cent. BaSO₄. This is delivered at Atlantic ports for about 23s. per ton with an additional duty of 7s. 3d. per ton. The imports for 1910 were:—crude, 18,992 short tons, and manufactured, 3,184 tons. The increased tariff has not had any appreciable effect on the barytes industry. The price of American ground barytes f.o.b. New York varies from 52s. to 62s. 6d. per ton, depending on the grade. The American "floated" has a limited market at about 75s. per ton, while the foreign "floated" barytes is sold for 86s, per ton f.o.b. New York. The principal use of barytes is in the paint industry. The mixture known as "Venice white lead" contains 50 per cent. barytes; "Hamburg white" contains 66 per cent., and "Dutch white" 75 per cent. Barytes makes a paint which is opaque, and is little acted upon by sulphuric acid. It is also used for the refining of sugar, enamelling of iron, and in the manufacture of lithophone.

The chief point is, that the raw material is worth at most only 23s. per ton, so that under existing conditions the deposits at North Pole are valueless at present. The prices for the refined ground article, too, are not sufficiently high to warrant its manufacture on the spot.

At a distance of about one mile east of the barytes deposit W. Breen is working a deposit for gold. This deposit, as far as I know, is unique for the district, and consists of a lode formed in the folds of the country rock, presumably the Nullagine Series.

The accompanying sketch, Plate II., of the lode shows clearly its mode of occurrence. Considering the formation of this lode from a broad point of view, it is undoubtedly similar to that of the quartz reef at Eastern Creek, etc., except that the lode does not contain quartz. It may be looked on as a layer of the country rock impregnated with gold contents from circulating solutions in which silica, etc., have been absent, or brought up in solution during the precipi-

tation of the gold. From a mining point of view, it is one of those examples of ore deposits which requires careful consideration, as it points strongly to the possibilities of similar deposits being found over extensive areas. The strike of the lode is N.E. and S.W., with an underlie at a low angle to the S.W. It will be particularly interesting to see whether the deposit continues for any distance on the underlie, and with this object in view the owner intends to sink a shaft to cut the deposit some 200 feet away from the outcrop.

So far, the ore sent to the Marble Bar battery has averaged about 70s. total gold contents per ton from 32 tons. After leaving the North Pole centre we followed the usual route to the asbestos deposit, passing over country already fully described by the Government Geologist in previous reports.

ASBESTOS DEPOSITS AT SOANESVILLE.

General Introduction.

Asbestos has, of late years, become not only a highly marketable mineral, but its uses are also constantly increasing. As the rocks with which it is associated are prevalent not only in certain parts of the Pilbara Goldfield, but also in other parts of Western Australia, there is a probability of deposits of asbestos being found in this State which may be of commercial value. Before dealing with the deposits under immediate notice, therefore, it might be of general interest and utility to give a $resum\delta$ as to the mode of occurrence of asbestos in other parts of the world, its physical and chemical properties, commercial uses, mining, milling, etc.

Under the general term "Asbestos" are classed several groups of minerals possessing more or less the same physical characteristics but variable chemical composition.

Formerly the word "Asbestos" was used to denote the fibrous variety of hornblende only, but now two main groups are classified under this term, viz.:—

```
Amphibole
(Hornblende)
Group

(1. Anthrophyllite.
2. Amphibole—
(a.) Tremolite.
(b.) Actinolite.
(c.) Mountain Wood and Mountain Leather.

3. Crocidolite.

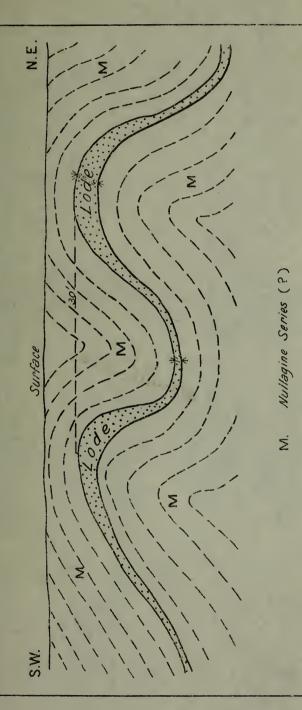
Serpentine
Group

(4. Serpentine—
(a.) Chrysotile.
(b.) Picrolite.

(5. Talc.
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NORTH POLE, PILBARA G.F



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Though there is a resemblance in the above groups or subdivisions of both chemical and physical qualities, still there often exist definite differences. As a rule these differences are chemical rather than physical.

From a chemical point of view the great difference between the two groups is the presence of a higher percentage of silica, lime, ferrous oxide, and sometimes alumina in the amphibole than in the serpentine group, with a corresponding loss in water and magnesia. The following is a table showing the comparative analyses, as computed from Dana's mineralogy:—

Table showing the Chemical Composition of certain Asbestiform Minerals.

	Tremolite.	Actinolite.	Crocid- olite.	Chryso- tile.	Tale.
Silica	57.70	57 · 13	51.22	43.56	61.95
Alumina		1.15		0.52	-98
Ferrous Oxide		$6 \cdot 39$	$34 \cdot 08$	$1 \cdot 62$	1.91
Manganese Oxide		0.65			
Magnesia	28.85	22.66	2.48	$41 \cdot 36$	30.87
Lime	$13 \cdot 35$	13.28	.03		
Water		1.57	4.80	13.79	4.08
MnO (Manganese Oxide)			$0.\overline{10}$		•••
Na O (Sodium Oxide)			7.07		

The first sub-group has not been put to any commercial use, so it will be passed over here and not dealt with further.

Tremolite is a calcium magnesium amphibole (a non-aluminous amphibole) (Ca Mg Fe) SiO $_{\rm s}$. Silica 57.70, Mg. 28.85, Ca. 13.35, Commercially it is not much used.

Actinolite is essentially a silicate of iron, calcium and magnesium (Ca Mg Fe) SiO₃. It is used commercially to a certain extent, but not very extensively, its chief uses at present being for weighting paper, roofing, and various forms of adulteration. The fibrous variety occurs in long, light green crystals, the green colour being due to the presence of iron. It never possesses the true fibre of asbestos, though it is sometimes mistaken for the same.

Mountain Leather and Mountain Wood are of no commercial value. They contain little, if any alumina, and do not separate into fibres, which renders them useless for most of the purposes for which asbestos is in use.

Crocidolite.—Commonly known a "Blue Asbestos," is a silicate of soda and iron. Silica 49.6, iron sesquioxide 22.00, iron protoxide 19.80, soda 8.60. This form possesses good fibre, which is easily parted, and has great tensile strength. As a commercial product, though, it fails on account of its non heat-resisting quality, yet it has a steady demand in the manufacture of roofing tiles, etc., where strength of fibre alone is essential.

Picrolite.—This is one of the common fibrous varieties of serpentine, and occurs in the latter in fibrous aggregations. It is common in most of the Canadian chrysotile asbestos mines, and is called by the miners "Bastard Asbestos." The fibres are sometimes long, but are usually harsh to the touch, are not flexible, nor easily separable, lack tensile strength, and are sometimes even brittle. It is not used in commerce, though its properties are such that there is little doubt that it will be put to some commercial use in the future.

Talc.—This mineral rarely possesses the fibrous nature of the other varieties of the serpentine group, though the chemical composition is similar, and it is found associated with serpentine, of which it is often an altered form. Commercially its value depends on its freedom from impurities. When of commercial use its colour must be white, and the texture should be soapy when ground to a powder. Its principal uses depend on the fact that it is an excellent heat resister, withstands alteration in temperature, is unaffected by moisture or fumes. Its common uses are for gas jets, table tops, furnace linings, etc. A use to which it has lately been put is the manufacture of paper with a glazed surface, for which it is more suitable than kaolin. Talc is common in most countries, and is essentially a derivative of any ferro-magnesian rock or mineral, more particularly, perhaps, serpentine.

Chrysotile.—This is undoubtedly the most important of the fibrous serpentines, and possesses all the qualities of first-class asbestos, viz., length of fibre, fineness of fibre, tensile strength, infusibility, heat and acid-resisting properties, and flexibility. Chrysotile asbestos possesses all these qualities to a marked degree. In the best varieties the fibre is long, and can be worked into threads so fine that they have the feel of cotton or silk rather than that of a mineral. Then, again, these threads can be made into a single thread so delicate as not to weigh more than one ounce to 100 yards of length, and yet with a tensile strength sufficient for weaving into fabrics. Temperatures of 2,000 to 3,000deg. F. are easily withstood, which renders it eminently suitable for heat-resisting purposes. For acid-resisting, however, it is slightly inferior to the hornblende variety, in which the percentage of silica is much higher in proportion to the base.

The following are some typical analyses of chrysotile fibre:-

е.	Authority.	Dr. J. I. Donald, Montreal.	Dr. Melton Hersey, Montreal.	do. do.	Dr. J. T. Donald, Montreal.	do. do.	do. do.	Dr. Milton Hersey, Montreal.	do. do.		do. do.		do. do.	E. S. Simpson, W.A.	
tile Fib	Total.	89.66	:	:	:	:	:	:	:	:	100.10	100.53	:	100.02	
. Chryso	H ₂ 0.	14.48	14.50	14.37	4.37	13.55	14.05	13.87	13.45	14.28	13.47	13.72	14.01	14.82	
sition of	Al ₂ O ₃ .	3.67	:	0.82	3.64	06.0	0.89	:	1.92	:	2.10	2.27	1.60	•44	
Compo	Fe0. Fe ₂ O ₃ .	2.41	3.31	2.60	2.26	2.81	69.0	2.95	2.92	2.23	1.97	0.87	2.08	1.92	
Сћетіса	MgO.	40.07	42.15	41.85	40.27	41.50	42.50	42.97	40.62	41.99	42.05	43.37	40.73	39.93	
ng the	SiO ₂ .	39.05	39.36	40.42	39.22	40.87	41.90	39.50	40.42	41.84	40.52	40.30	42.20	45.98	4
Table showing the Chemical Composition of Chrysotile Fibre	Locality.	Canadian— Thetford	Black Lake (Amalg. Asb. Corp.) B.C.	Black Lake (Amalg. Asb. Corp.) Standard Ouarries	Black Lake Southwark Mine	East Broughton	East Broughton, Glasgow Montreal Mine	East Broughton Frontenac	Eastmen	Dunnville	Lauretian (Templenton)	Italian	Western Australian	Soanesville	

It will be seen from the above analyses that the minerals agree very closely in chemical composition, the most variable constituent being the alumina.

Referring to the above analyses, F. Cirkel, M.E., makes the following statement:—

A most interesting feature in connection with these analyses is the great similarity of the percentage composition of fibre, which outwardly shows the qualities of great silkiness, flexibility, and strength. It is also found that the amount of water varies only between 13.47 and 14.50. The inference therefore is that good, commercial asbestos fibre, be it "hornblende" (like the Italian) or chrysotile (like the Canadian), always contains a certain amount of water, which, as the analyses indicate, does not fall below 13 per cent., while all the harsh, brittle fibres of tremolite, actinolite, and also some of the hornblende group, contain little water, the amount varying between 1.0 and 5.0 per cent.

In external appearance and chemical composition they are much alike, indeed so much so that when the crystals occur in long slender prisms or in radiating masses, the mineral is called actinolite, but when in long, slender, flexible fibres, easily separable, it is named asbestos. The difference between good and bad asbestos can be at once perceived by subjecting the fibres, or long slender crystals, to tearing and twisting and bending between the fingers. The good asbestos, applicable to the finer purposes of manufacture, will give up silky threads of great elasticity and amenable to the various spinning processes, while bad asbestos will split up into harsh and somewhat brittle fibres, occasionally breaking up when rubbed between the fingers. The heat-resisting properties of both these varieties of asbestos is approximately the same, so that when this characteristic of the asbestos is the only quality desired the amphibole variety is found to be equally as satisfactory as the chrysotile, but whenever strength of fibre as well as non-conductivity of heat is desired, the chrysotile variety is the only one that can be used to advantage.

The chemical composition of certain hornblendes varies considerably. but in every instance the percentage of MgO is under 27, silica is usually in excess of 50 per cent., and either lime or iron is present from 13 to 26 per cent., whilst water rarely reaches 4 per cent.

From the above it is apparent that there are unmistakeable differences in the chemical composition of the two groups of minerals. It is worthy of note that the two analyses of the samples taken from the asbestos mine near Cooglegong, W.A., are of the first quality and of the chrysotile variety.

Owing to the low percentage of alumina, and the total absence of lime, it is evident that the Italian sample is not of the hornblende variety but is a chrysotile.

Occurrences of Asbestos.—From a perusal of the various reports on the occurrences of asbestos worked on a commercial scale in other parts of the world, it is significant that the mineral is nearly always found associated with serpentine rocks.

The Canadian and Russian varieties are undoubtedly chrysotile. If the analysis of the Italian variety as quoted in F. Cirkel's *

^{*} p.p. 239, F. Cirkel.

work be correct, this variety is also chrysotile and not hornblende. In West Griqualand, a commercial form of asbestos has a chemical analysis which would show it to be of the crocidolite variety, rich in iron. This is the only locality in which the asbestos has been mined where it has not been found associated with the serpentine rock, but (according to F. Cirkel) occurs in a brown shale. The occurrence of serpentine rock is usually in the form of more or less narrow bands, running parallel to granitic masses, and intruded by dykes which may be either basic or acid. Considerable discussion has arisen as to how the asbestos is actually formed in the serpentine rock. Of the ferro-magnesian silicates there are two main classes, the non-aluminous and the aluminous.

The most common alteration products of the non-aluminous variety are tale and serpentine. The non-aluminous pyroxenes and amphiboles usually pass into tale, the chrysolites (olivines) more commonly into serpentine.

Chrysolite is essentially a silicate of magnesia and iron (Mg. Fe.) ${
m SiO_4}.$ Silica 41.39, magnesia 50.9, iron 7.71.

Serpentine has a composition of 3 MgO, 2 SiO₂, 2 H₂O, Silica 44.1, magnesia 43.00, and water 12.9. It is, therefore, a hydrated silicate of magnesia, and can be formed from a chrysolite by the abstraction of the part of the iron and magnesia and the replacement of the same with water. Such chemical changes cause increase of volume and pressure and consequent crushing and faulting, etc. When basic or acid intrusions occur through or around such an area, in the readjustment of the serventine rock, when cooling takes place and pressure is removed, etc., cracks are formed. Circulating water dissolves the serpentine rock and precipitates it in these cracks. The filling of the fissures apparently takes place from the sides, as, almost invariably, the long axis of the asbestos fibre is at right angles to the wall. Furthermore, in the fibre itself there is usually a more or less distinct junction visible, showing where the ends of the two sets of fibres have met. This junction is often scarcely visible, at other times it is very distinct, owing to a thin parting of serpentine rock or seam of foreign mineral, such as chromite, being present.

In what is known as "slip fibre," the fibre lies lengthwise with the sides of the fissures, and here its occurrence is probably due to the shearing of the serpentine itself, and the formation of what might be termed fibrous serpentine.

Mr. Hyde Pratt * holds that:—

"It can be conclusively shown in nearly all cases, that the serpentines in which chrysotile asbestos is found is of igneous origin. Some of the main points leading up to this conclusion are the presence in the serpentine of the mineral chromite either in small grains or as

^{*} The United States Geological Survey, 1904, Bulletin on Asbestos.

segregated masses, the almost entire absence of carbonates except those which are of undoubtedly secondary origin, the occurrence of small masses of gneiss granites or other rocks entirely surrounded by the serpentine, which have undoubtedly been broken off from the main masses of those rocks during the intrusion of the rock of which the serpentine is an altered facies. The blunt lenticular form which so many of these masses of serpentine are observed to have, and the sharp line of separation of the masses of serpentine from the surrounding country rock. The original rock on cooling would solidify first along its contact with the rocks through which it had been penetrated, to where it was in contact with any included masses of country rock that had been broken off during the intrusion of the molten magma. The outer portions of the molten rock would then cool much more suddenly than the interior portions, and there would be a tendency for them to develop cracks and parting planes.

In the alteration of these primary rocks to serpentine through the agency of aqueous solutions, vapours, etc., there would be, perhaps to some extent at least, a widening of the cracks, but, in the end, they would be filled with serpentine deposited from the aqueous solutions from their walls, and the resulting fibrous structure of the serpentine filling these seams represents the nearest approach to a true crysallisation that the mineral serpentine assumes, except when it is found as a pseudomorph after another mineral. It is probable that this chrysotile asbestos may have been formed some time before the complete alteration of the primary rock into serpentine. This is emphasised by the fact that in the southern part of the United States where these basic magnesian rocks have been but partly altered to serpentine, seams of chrysotile asbestos are occasionally found, and that in others seams of serpentine are found, almost entirely enclosed by a peridotite rock which is altered but little into serpentine.

Dr. A. P. Low summarises thus:—

The cracks were probably formed by the shrinkage of the mass, and perhaps, in part, by the crushing action of the same pressure which lengthened and flattened the serpentine areas and at the same time made the associated rock schistose. The asbestos appears to the writer to have been deposited in the cracks under great pressure from super-heated waters, which penetrating the rock absorbed the material of the serpentine until the solution became a saturated one. While cooling, the mineral would be deposited in the cracks. In the Thetford and Black Lake areas (Canada) masses and dykes of granite have been intruded into the serpentine, and these probably account for the necessary pressure and heated water to form the asbestos there.

It is worthy of note that in estimating the length (the staple) of asbestos fibre for commercial purposes the total width of the seam must be reduced to the true length of unbroken fibre, measured from the junction in the seam to either side. This, of course, does not apply to fibre in which the junction is absent, but this occurrence is rare except in "slip fibre," and even in this form the determination of the true length of fibre requires the experience of an expert. The length of asbestos fibre varies from a small fraction of an inch up to many inches. In the Canadian mines fibre having a length of "4in, and over, is considered first class, and can be manufactured into fabrics, etc., with modern machinery.

The bulk of the mineral occurs in lengths from 4 inch to ½ inch, and, though of less value, forms the backbone of the industry. It might be said, however, that provided asbestos occurs in sufficient quantity of any length it has a commercial value.

Methods employed in Recovery of Asbestos Fibre.—To trace the various methods which have been adopted for the recovery of asbestos fibre from the matrix would be too lengthy a matter for the present purpose. Suffice it to say that various processes have gradually evolved from hand picking or crushing, to the use of machinery improved from year to year until the mineral can now be recovered in the rough or in a prepared form at a cost which renders its production cheap enough for commercial utility.

Briefly, the typical modern plant as used in the Canadian Works is set out by F. Cirkel as follows:—

1st Part of Separation.

All the asbestos rock and fibres produced at the mines are dumped into ore-bin (a), crushed in jaw breaker (b), raised by bucket elevator (c) to a shoot which empties into rotary drier (d). Bucket elevator (e) raises the material to a belt conveyor (f), transporting it back to the other side of the drier, and delivering it to the second drier (g). The end of the latter is perforated and effects a division of the rock into "medium" and "rough." The "rough" is again crushed in a second jaw breaker, while the "medium" or undersize falls directly upon the belt conveyor (h), which also takes up all the crushed material from the breaker. The belt conveyor then delivers all crushed material to two ore-bins (k1), (k2), which discharge through an automatic feeder to the Butterworth and Low crusher (1). A bncket conveyor (m) discharges the rock into a fitenzer (n), and after thorough diminution the material falls on a screen (o), when a fan (p1) takes up all the liberated fibre, and deposits the same on collector (s1). The residue from screen (o) is delivered to cyclones (q), the discharge of the latter is thrown on screens (r1). Here two separations of sand and fibre are effected, the fibre being taken up by fan (p2) and deposited into collector (s2), the sand disappearing under the screens into a hopper which empties in the sand conveyor (u).

2nd Part of Separation.

All fibre extracted from the rock is now placed in collectors (s¹) and (s²). From here it passes through the grading screen (t¹) having arms within moving in opposite directions. In this screen two grades are made, long fibre thrown on screen (r²), short fibre (or undersized) thrown on screen (r³). These screens effect a partial separation of the sand from the fibre, the former falling on the sand conveyor (u), and the latter being sucked up and placed in two collectors (s³) and (s⁴). From collector (s³) the fibre is again screened in revolving screen (t²), the over-size now constituting fibre No. 1, and the undersize being again treated on an oscillating screen (r¹) in order to get rid of the sand. Whatever fibre remains on this screen is taken up by the fan (p⁵) and is deposited on collectors (s³). The No. II, fibre on collector (s⁴) goes through the same process of cleaning as the No. I. fibre described above, and the final results are a No. II, and III, grade in addition to the No. I. grade referred to.

The following chart No. I. represents in graphic form a summary of the foregoing descriptive outline of the various stages through which the longer fibre has to pass before it is ready for the market.*

In some mills a picking table is inserted between the duplex crusher and the elevator. Boys are employed in picking out the dead rock, long asbestos fibre and any scrap iron or accidental rubbish. Magnets are also in vogue at many mills to draw off any magnetic iron.

Asbestos consists of the bulk of the sand and tailings from the shaking screens ground to a fine asbestos powder.

Cost of Labour in typical Canadian Mills.—On one mill treating about 150 tons of rock per day or 75 tons per eight hours, the labour costs amount to £5 per day. As this particular mine produces seven tons of fibre per day the cost per ton of fibre amounts to 14s 6d. The total number of men employed is 13.

On another plant, treating 125 tons per eight hours, the cost per ton of ore treated is £7 per day for 19 men employed, working out at 14s. 6d. per ton of asbestos won.

In dealing with the total costs of treatment the variable nature of the ore, different mining conditions, etc., make it almost impossible to give even approximate figures. In the Broughton district, where all the rock passes through the mill the cost per ton of asbestos won is from £2 12s. to £5 per ton. These do not include administration expenses. In the Thetford and Black Lake quarries where the production of crude enters into the mine costs, the average cost of extraction, crude and mill fibre combined, is placed at from £4 to £5 12s. per ton, exclusive of expenses for management, offices, insurance, marketing and amortization, etc.

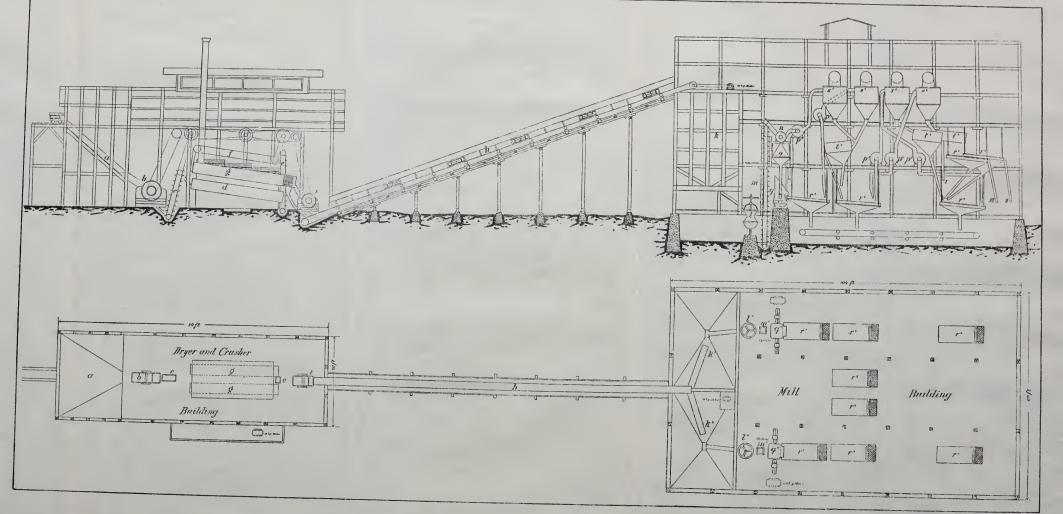
Cost of Mill and Mine Equipment.—For a plant built to handle 240 tons of asbestos rock per 24 hours and capable of the addition of two extra cyclones the writer quotes total cost of £11,009 with a further cost of £4,000 for mine equipment.

Another mill containing four cyclones, cost £36,000, whilst one of six cyclones cost £44,000.

These figures are merely significant of what mills have cost under certain conditions and must not be taken as standard prices for mills of a definite capacity.

Percentage of Milling Material in Total Rock Mined.—Referring to this subject in connection with his report on Canadian chrysotile mines, F. Cirkel states that of the total rock mined 20 per cent. is the minimum amount of ore that goes to the

^{*} Fritz Cirkel, Monograph on Asbestos.



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CHART I.

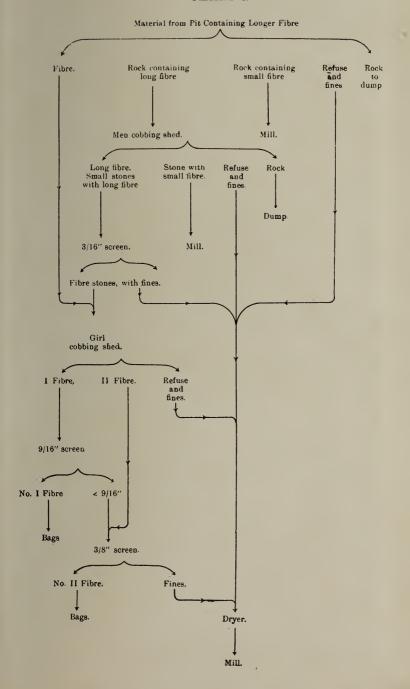
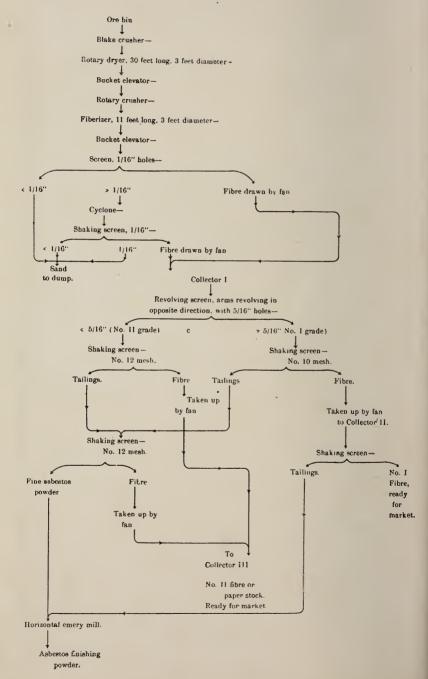


CHART II.



mill with a maximum of 80 per cent, in some mines. He strikes an average for the whole of the Canadian mines at from 30 to 60 per cent. From this about six to 10 per cent, of fibre is extracted in the Black Lake vein quarries and 7 to 12 per cent, in the Broughton or slip fibre quarries.

The percentage of crude produced can be put down roughly at from 0.25 to 75 per cent. of the total rock mined, though isolated cases produce much more than this.

Production and Value.—Canada produces far more asbestos than all other countries, Russia being the only other producer of any great importance.

The following are the latest returns to hand:—

Table showing the Production of Asbestos by Countries.

Country. Year.		Year.	Asbe	stos.	Asbestic.		
Canada Russia		.:	1910 1909	Short tons. 73,678 14,700	Value. £ 501,227 Not known	Short tons. 24,707	Value. £ 3,672
U.S.A.			1910	3,630	13,406		1 ::

Asbestos is graded into six products for market purposes:—

Va	lue	per	short	ton.
----	-----	-----	-------	------

No.	1 Crude					£52—72
No.	2 Crude					£30—52
No.	3 Asbestos	fibre,	according	to	grading	£1030
No.	4 ,,	,,	,,		,,	£5—10
No.						£2/10—5

No. 6 , , , , , , $\pounds \frac{10-3}{10-3}$

The Soanesville Deposits.

These deposits are found in some rough country lying to the west of the Shaw River. Roughly, they are about 65 miles southwest from Marble Bar and 110 miles to the south of Port Hedland.

Topography.—After passing Cooglegong, an old tin mining centre on the Marble Bar to Roebourne Road, the country changes considerably, both geologically and topographically as one approaches the Shaw River. In place of the flat, more or less irregular granite country, extremely rough hills and ranges are encountered. These consist of what have been named by the Government Geologist the Nullagine Series of rocks and form one of the roughest forms of country for travel or transport. The contours of these hills and ranges are as irregular as can be imagined, and there is apparently no definite system in their formation. Rising to a height of sometimes two or three hundred feet above the



Fig. 11.

Negs. 853-4.

Soanesville, looking North.

Photo: T. Blatchford.



Fig. 12.

Soanesville, looking South.

Photo: T. Blatchford.

Negs. 855-6.

normal level, the old sediments have apparently been subjected to much change by earth movements and since have been cut through and through with water-courses running in all directions. In the centre of this complex are the asbestos deposits.



Geological Features of the Asbestos Area.—Briefly, the geological features are a mass of highly basic rock, probably an altered peridotite, now a serpentine which has since been intruded by several dolerite dykes. Bounding the serpentine rock on all sides and covering up the edges are the Nullagine Series of rocks.

Neg. 860

A good conception of these features can be gained by glancing at the accompanying photos., Figs. 11 to 15, taken especially for the purpose. As seen in the field, the serpentine rock forms a belt of rock exposed at the surface for a maximum width of half-a-mile



Photo: T. Blatchford.

and a length of some two and a-half miles. That these are not anything like the true dimensions is born out by the fact that in no instance could the true boundaries be defined and that the rock outcrops again from under the Nullagine beds, several miles to the

south and west of Soanesville. From the accompanying section it will be apparent that the serpentine is the altered product of a rock which has intruded under the old Nullagine sediments, slightly lifting

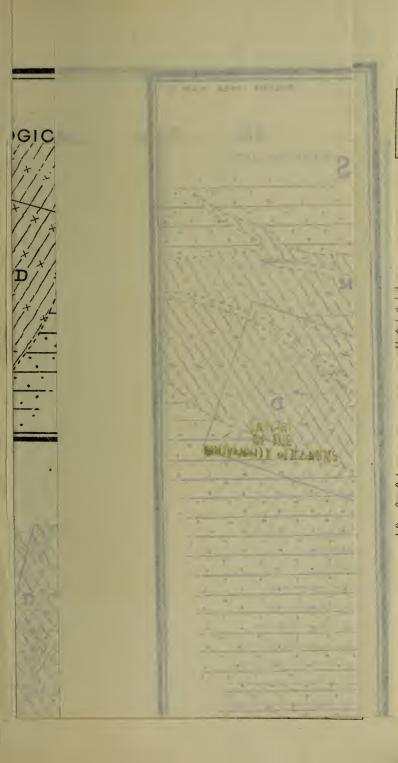


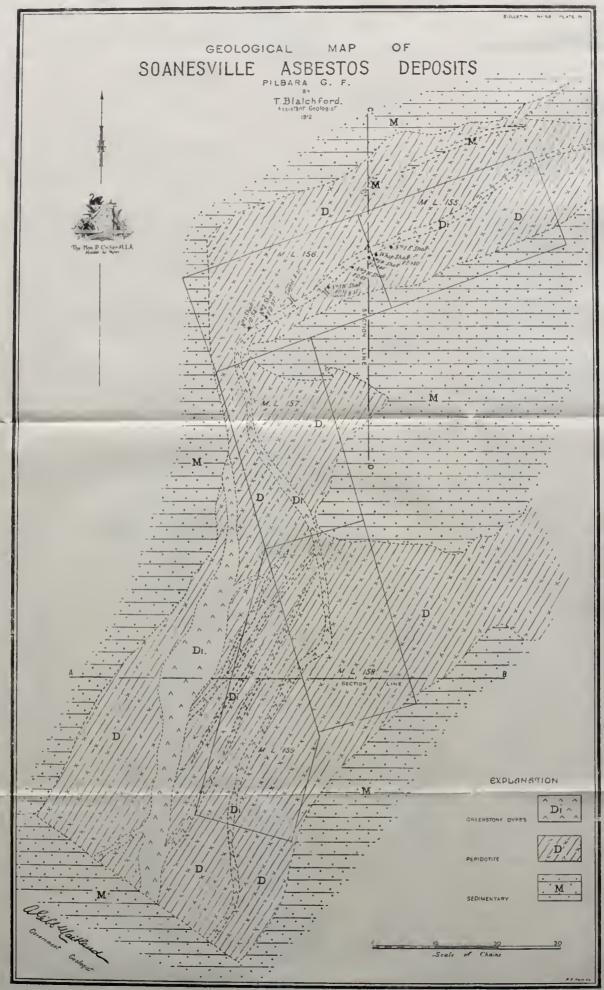
Rockhole near entrance to Gorge leading to Soanesville (the only drinking water) Photo: T. Blatchford.

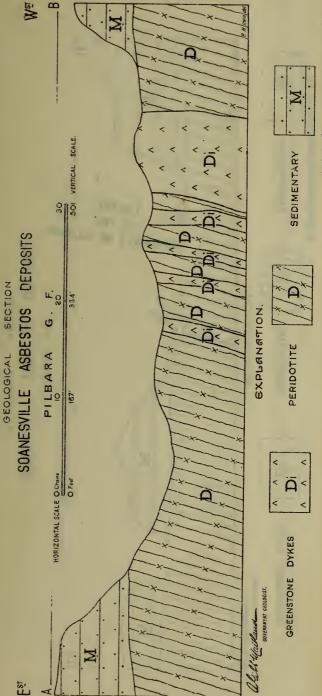
the same, and that this rock in turn was intruded by basic dolerite dykes, which not only cut through the serpentine rocks but also through the overlying Nullagine Series.

In the area included in the accompanying map, Plate IV., the serpentine rock outcrops are numerous, but are usually much decomposed and weathered.

ig. 15.







M.J. Pether, Covernment Lithographer, Perth. W. A.



The following is a chemical analysis of a typical sample of the serpentine from this locality made in the Survey Laboratory:—

G.S.M. [12658] L310	7,		р	er cent.
SiO ₂		 		$38 \cdot 84$
TiO_{2}^{-}		 		0.04
CO_2		 		trace
$P_2 \tilde{O}_5$		 		trace
$H_2()$		 		$12 \cdot 81$
K ₂ O		 		$0 \cdot 13$
Na ₂ O		 		0.10
$\mathrm{Ca} ilde{\mathrm{O}}$		 		0.03
MgO		 		$34 \cdot 06$
MnO		 		trace
FeO		 		0.53
Fe ₂ O ₃		 		$9 \cdot 63$
Al_2O_3		 		$2 \cdot 10$
$\mathrm{Cr}_{\mathfrak{o}}\mathrm{O}_{\mathfrak{o}}$		 		0.79
s		 		0.10
H ₂ O		 		1.00
	Total	 		100 · 16

Fairly good sections are to be seen, however, in some of the mine workings, though only in the vicinity of the dolerite dykes. Here the rock is much altered in places, appearing to be more or less dehydrated, crushed and fractured.

A distinct schistosity at times is also noticeable. Away from the dykes the rock appears to be massive and, in the surface rocks, devoid of any characteristic structure, except that the weathered surfaces sometimes show a honey-combed structure.

The dolerite dykes have, undoubtedly, intruded not only the serpentine rock, but reached far up into the overlying Nullagine Series. *Vide* Figs. 11 to 15.

These dykes, of which several occur, are of no great width and have a more or less persistent north and south strike. It is undoubtedly to them that the asbestos owes its origin.

In the field the dolerites are seen outcropping with great persistence, and can be easily distinguished from the encasing serpentine rock by their coarse texture, greater hardness, and the fact that they usually weather to a red colour on the outside of the individual pieces.

The other prevailing rock types are the Nullagine Series, which overlies the country for some miles round from the locality under notice. This series of rocks has been fully described in "The Mineral Resources of the Pilbara Goldfields," by A. Gibb Maitland, Government Geologist. Briefly, they consist of various types of sedimentary rocks, sandstones, grits, conglomerates, etc., which have subsequently been much altered. In the vicinity of the asbestos deposits they may be seen forming the cliffs and surround-

ing higher ground, and partly covering the serpentine rock area. For the most part they occur here in the form of quartzites derived from much altered sandstones, or the finer sedimentary rock forms, but some few miles to the north, in the vicinity of "Keep it Dark," the prevailing conglomerate types are much in evidence. Being for the most part highly silicified, they resist denudation more persistently than the intruding greenstones; on account of this fact, valleys or passes through sediments are often noticeable on account of the earlier weathering and removal of the intrusive greenstone masses, and by noticing such, help is often accorded in finding the dykes.

Some of the accompanying photos, Figs. 11 to 15, illustrate this feature of the landscape.

The Asbestos Deposits.—Although seams of asbestos have been found in many places on the area included in the accompanying map, Plate IV., prospecting has not been carried on to any extent except in two vein deposits on its northern end.

Locally, these deposits are known as "A" and "B" lodes, the "A" being on the western and the "B" on the eastern side of the main dolerite dyke.

The workings on "A" lode consist of two shafts sunk to a vertical depth of 54 and 97 feet respectively, and connected, I believe, at the 50 feet level with a drive 163 feet in length. These workings were inaccessible at the date of my visit. On the surface the occurrence of the asbestos veins was apparent. Here the dolerite dyke forms the hanging wall to the asbestos veins, and I believe the same obtains at the bottom of the shafts and the drive. The dyke underlies to the east at an angle of about 70 degrees and, I think, approximately north-east to south-west.

The veins of asbestos are lying close up to the dolerite dyke and run parallel to the same, forming a kind of banded formation about two feet in thickness. The fibre of the asbestos is short and fit only for mill treatment, as there is scarcely any long enough to warrant cobbing for crude. The fibre near the surface is much decomposed, judging from the material on the dumps, but improves in quality as greater depths are reached. Further to the north and close to the dyke "A" the lode has been traced for a considerable distance, but does not apparently improve in size or quality. A tunnel has also been driven westward for a distance of 54 feet into the serpentine to try and locate fresh seams. In this tunnel there is no evidence of asbestos veins, in fact the reverse, for the serpentine rock throughout is very much altered and full of joints, probably due to contact metamorphism caused by the dolerite dyke.

On the "B" lode five shafts have been sunk to vertical depths of from 55 to 144 feet.

The two deepest, viz., the "Whip Shaft," and "No. 1 West," are connected by a drive at the 140 feet level. This drive is in all about 300 feet long, and exposes the asbestos veins for the whole

Fig. 16.



Photo: R. H. Irwin. Neg. 902.

Asbestos from "A" Lode, Soanesville.

of that distance. The average width of the veins here is slightly greater than that in the "A" lode, and is about two feet six inches to three feet, taken for the whole length of the drive, with fibre showing in both faces. In the northern end of the drive some very

Photo: T. Blatchford.

Neg. 903.

fine asbestos fibre was showing, and I was informed that this was the bottom of a shoot of ore which was some 30 feet in length, and from which most of the cobbed ore had been won. Some of the fibre in this part of the lode had a length of several inches and was of



Fig. 17.

exceptional quality. The fibre in the other portion of the drive was only fit for mill treatment. All the fibre veins as in "A" lode, are lying close up to the dolerite dyke, the dyke forming the footwall of the "lode."

The percentage of fibre in "B" lode is difficult to estimate, even roughly, for at times it is very low and the fibre very small,



Photo: T. Blatchford.

while on the other hand, in places the fibre is first class and abundant. Probably the most disappointing feature from a mining point is the narrowness of the deposit.

In the Canadian and Russian asbestos deposits, the mineral is worked in large quarries, and this form of mining, besides being very inexpensive, also provides for the low cost of treatment per ton, on account of the enormous tonnage which can be handled. It is obvious that the width of the Pilbara deposits exploited to date would necessitate high running costs, for in stoping much barren as well as milling rock would have to be taken out to enable mining operations to be carried on at all.

Fig. 19.

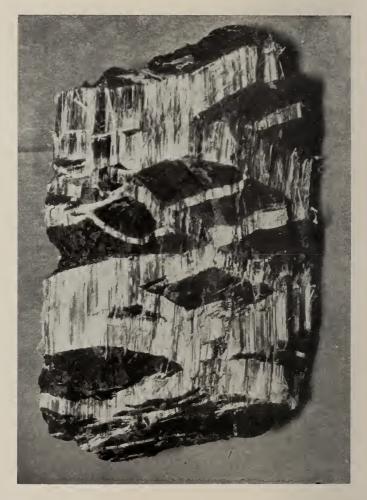


Photo: R. H. Irwin. Neg. 900. Serpentine Rock showing crossing of Asbestcs Veins.

Although there were numerous other workings on the "B" lode, there was no evidence of the veins spreading out to a greater width than in the workings already described. An adit was also

put in to the eastward to exploit the serpentine for fresh deposits, but without success. The serpentine on this side of the dyke is perhaps not altered to quite such an extent as in the " Λ " tunnel,

Fig. 20.



Photo: T. Blatchford. Neg. 861. Entrance to Gorge leading to Soanesville, showing dip of strata.

but in most respects is more or less identical. About one mile to the south of the workings described above, asbestos veins are found occurring along the sides of numerous other dolerite dykes, but these have not been exploited to any extent. As far as can be seen in the shallow trenches where prospecting has been carried on, the occurrence of the asbestos veins is identical with those in the "A" and "B" lodes.

Up to the present the boundaries of the serpentine rock are hidden by the Nullagine Series of altered sediments. This is unfortunate, as there should be more possibility of finding large formations of asbestos fibre near the boundaries of the serpentine than elsewhere. In any case I would strongly advise that this point be borne in mind by those who are prospecting for asbestos in this district, for at any time the contacts of the serpentine with the surrounding rocks may be found exposed.

Calculating on the prices paid for crude Canadian asbestos, it would seem that crude Pilbara asbestos should be worth from £40 to £50 per ton on the European market.

The total cost of producing the marketable product at Pilbara and putting it on a local or foreign market, including labour of mining, cobbing, and bagging, transport, freight, etc., would probably not exceed £20 per ton. There is, therefore, a good margin of profit in working good crude fibre.

In estimating the value of milling fibre, the difficulties are many. If the average price of all grades of mill fibre be taken, the Canadian price is £6 per ton. As has already been pointed out, the value of the different grades of mill fibre varies enormously, viz., from £3 to £20 per ton.

Taking the asbestos veins as they stand exposed in the workings already described, and after making due allowance for high mining costs under existing conditions, it would cost at least 20s. per ton to mine and mill the asbestos rock on the spot. If the percentage of recoverable fibre and milling rock be 20 this would mean a cost of £5 to produce one ton of mill fibre, exclusive of cartage, freight, realisation charges, etc.

I consider that a fair amount of "B" lode might average 20 per cent. fibre, but the lodes are not sufficiently developed to form any definite opinion. There is no doubt that the "B" lode is looking better in the bottom than in the upper levels, and there is no geological reason why it should not continue to such a depth as it is possible to mine and for indefinite distances along the walls of the dolerite dyke.

The following are the returns from official records for crude asbestos shipped from Soauesville, Pilbara Goldfield:—

Year.			Tons.	£
1908	 	 	$40 \cdot 00$	 1,600
1909	 	 	2.83	 154

From the asbestos centre we journeyed through Hillside, Woodstock, and Abadoo Stations on to Wodgina; with one exception the country traversed was granitic.



"Black Range," Hillside Station.

At Hillside Station an interesting geological feature is seen in what is known as the Black Range. The accompanying photo., Fig.

Neg. 857. General View of Fig. 21. Photo: T. Blatchford.

Fig. 22.

21, shows the general apearance of this range. Viewed from a distance the effect is curious, as the dark portions appear almost black

on a light foreground. The black appearance is due to a very perfect diabase (?) dyke, which has apparently filled in an enormous fis-



Neg. 876.

Shaw River at Hillside Station, showing section of "Black Range."

Photo: T. Blatchford.

sure in the granite. Owing to this dyke subsequently resisting the action of denudation more than the enclosing granite, it now stands out in bold relief against the surrounding flat granite country.

ig. 23.

At Wodgina some time was spent in inspecting the various tin mines and the Cassiterite Tin Mine in particular. The following

Fig. 24.

is a report on the same in detail, with photos., Figs. 27, 28, and 29, illustrating some of the features, geological and otherwise.

Neg. 877.

Shaw River at Hillside Station.

hoto: T. Blatchford.



Neg. 878.

Shaw River at Hillside Station.

Photo: T. Blatchford.



Fig. 26.

Neg. 875.

Shaw River at Hillside Station.

Photo: T. Blatchford.

THE WODGINA TINFIELD.

Bulletin 40 of the Geological Survey contains a comprehensive report on the Wodgina tinfield, which includes a minute description

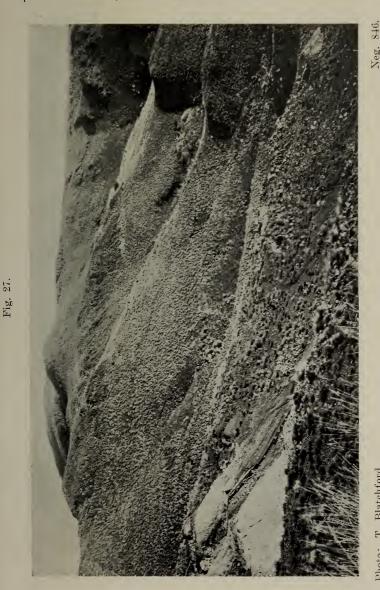
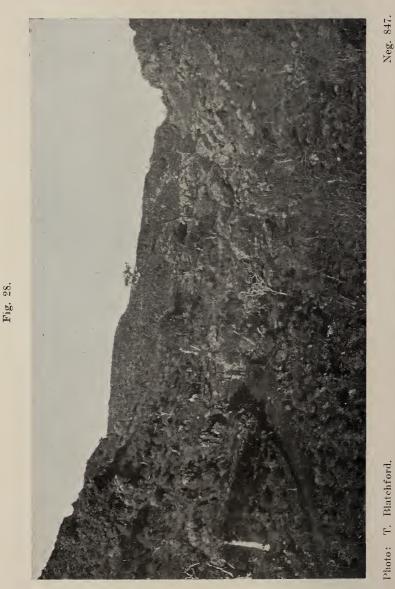


Photo: T. Blatchford.

Neg. 846.

Portion of Hill to south of Cassiterite Mine, showing Pegmatite Dykes crossing each other.

of the geological features, etc., of the district, and is accompanied by explanatory sketch maps and sections. In addition, the report embraces a description of the mines then in operation, and the returns from same up to the end of the year 1905. Some two years



later, August 8th, 1907, Mr. Montgomery, State Mining Engineer, whilst compiling a report on the Pilbara and West Pilbara Gold-fields, with special reference to the proposed railway from the coast



Photo: T. Blatchford.

Negs. 844-5. "Cassiterite" Mine, Wodgina, and Wodgina Townsite.

to Marble Bar, added more useful information on the geological and mining features of the Wodgina District, with a description of the mines in operation at the date of his visit.

In addition, H. P. Woodward, Assistant Government Geologist, has briefly referred to this locality,* also Inspector Cleland.†

Since 1907, and up to a very recent date, prospecting must have been, with very few exceptions, almost at a standstill, for the mines described in the foregoing reports are practically in the same condition now as when they were inspected. The one exception is the Cassiterite Mine which stands out by itself as the only developed mine on the field. Quite recently, however, in an area which had been previously more or less overlooked, some very promising tin lodes (stanniferous pegmatite dykes) have been prospected, from which considerable quantities of tin oxide have already been won. As these latter discoveries are on the western side of the hills I purpose calling them the "Western Lodes," to distinguish them from the "Eastern Lodes" on the eastern side of the range, and more or less in the immediate vicinity of the Cassiterite Tin Mine.

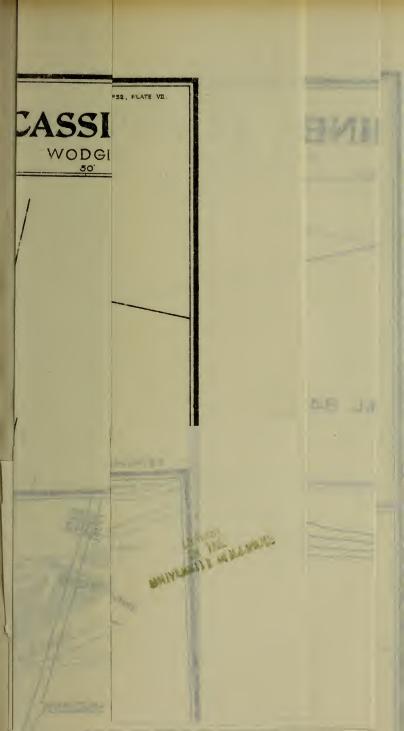
The Eastern Lodes.

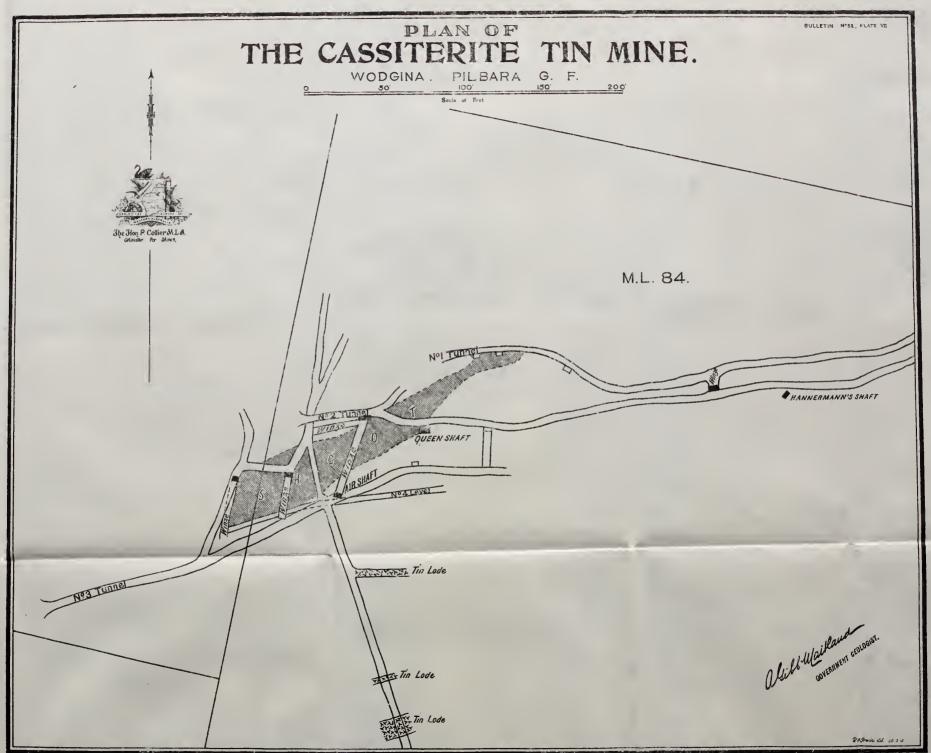
With few exceptions, notably the Cassiterite Tin Mine, very little, if any, prospecting has been done on the Eastern Lodes since the visits of the Government Geologist, the State Mining Engineer, the Assistant Government Geologist, and Inspector Cleland, and their full descriptions of the mining operations as seen in Bulletin 40 of the Geological Survey, and the Annual Reports of the Mines Department, 1909, still stands as complete—likewise the Sketch Geological Maps and Geological Notes. All returns from the various mines have been brought up to date in the appended returns compiled from official records.

The "Cassiterite" Tin Mine.—The early history of this mine has been fully written up in Bulletin 40. Since the State Mining Engineer's visit, however, considerable prospecting and development has opened the main lode up systematically to a vertical depth of some 225 feet, with a winze 70 feet in the bottom level.

As can be seen from the accompanying plans, Plates VII. and VIII., the main development work consisted in driving adits at different levels on the side of the hill and following the course of the lode. Taking each level separately the following is a brief description of the size of the lode and the amount of stoping done. fortunately, there was no available information as to the grade of ore from the individual stopes, the only information on this point being the gross tonnage of ore treated and the gross tonnage of tin won.

Vide Annual Report, 1909, p. 17, et seq.
 † Annual Report Mines, 1909, pp. 103-104, and Appendix to this Bulletiu.





No. 1 Level.—The total length of this level is about 25 feet, it extends from side to side, through the crown of the hill. Unfortunately the timber has been destroyed by ants and weathering, and it is now inaccessible. A large quantity of the ore has, however, been stoped out from the level to the surface with a stoping width of some four feet.

No. 2 Level.—This level is about 50 feet below No. 1 level and opens out on the western side of the hill. The total length is about 450 feet. Forty feet from the mouth of the tunnel, the ore body, which has an average width of about five feet, has been stoped practically to No. 1 level for a distance of 125 feet. Another stope starts about 300 feet in from the mouth of the tunnel, and extends along the drive, eastward, for a distance of 125 feet, the eastern end extending upwards to the surface. Between these two stopes the ground is intact, and, except for one small portion, about 20 feet long, the lode is well defined and has an average width of at least five feet in the drive.

No. 3 Level.—At the western side of the lode an ore body was worked at the No. 2 level, and for some time it was doubtful whether it was the main lode or a cross lode. When Nos. 1 and 2 winzes were sunk from No. 2 level this doubtful ore body was found to be a continuation of the main ore body, and the major portion of it has since been stoped between levels Nos. 2 and 3, for, though smaller than the average, it contained higher values. As can be seen from the accompanying plan, Plate VII., the bulk of the ore between Nos. 1 and 3 winzes has been stoped out to the No. 2 level for a width of about five feet.

No. 4 Level.—At a vertical depth of 50 feet from No. 3 level, another level (No. 4) has been opened out for a horizontal distance of 130 feet; the whole block of ore has since been stoped out between these levels. The average width of lode stoped was about five feet, though in places the width increases up to 14 feet, notably in the vicinity of No. 3 winze, No. 4 level.

Further development downwards was confined to a winze sunk from No. 4 level under No. 1 winze. At the time of my visit this winze was full of water, but I was informed by the manager of the mine that the winze is 70 feet deep, and that the water level is about 55 feet below the level. Whether this is the true water level for this part of the country is doubtful, for certainly the water level in the well on the flat lies far below this point.

The lode opened out in the above described workings is a true fissure lode of the acid dyke variety. In appearance it varies from almost pure quartz to a mixture of felspar and mica to nearly pure felspar or mica. Tin oxide is found throughout the lode in varying proportions, and occurs both in the coarse and angular and also,

not uncommonly, in a very fine form throughout the rock mass. Taken as a whole, most of the mineral occurs, however, in the walls of the lode, and is rarely found evenly distributed right across a face.

Tin ore also occurs in bunches along either side of the lode, preferably on the footwall. Some very large blocks of the pure oxide have been won from this source, reaching a weight, at times, of several hundredweight.

On account of the erratic nature of the oxide in the ore body, and the bunches of tin in the walls, the latter play an important part in the output, it makes sampling or ore reserve estimation almost an impossibility. Consequently, in summing up the value of this mine, one is confined to the gross tonnage and the amount of tin produced from such.

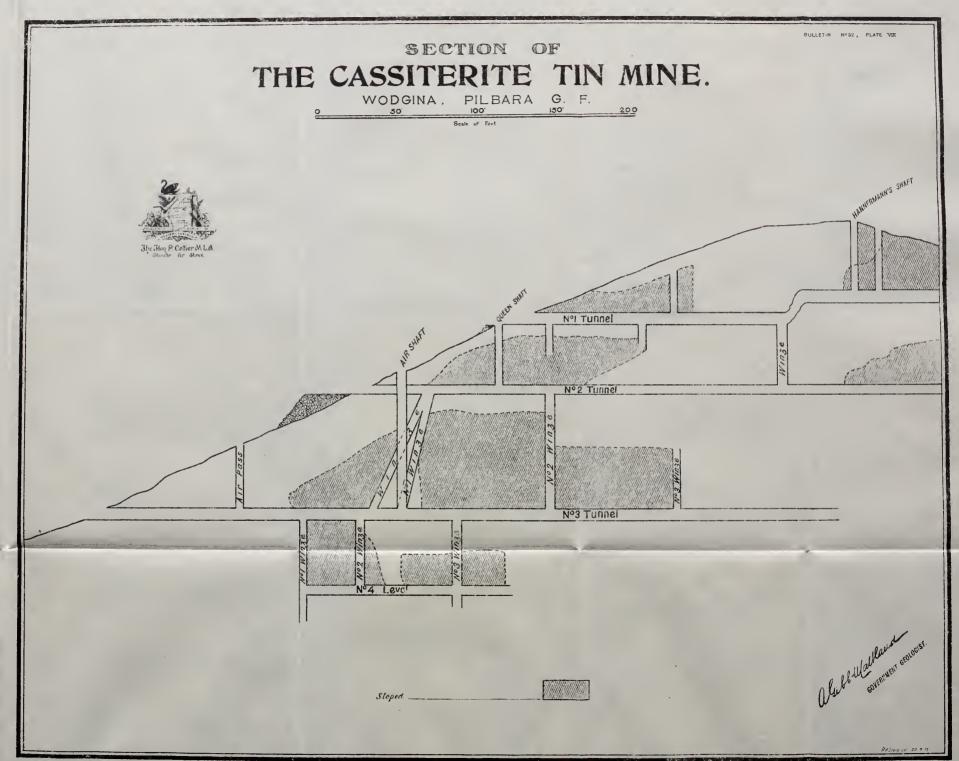
One pleasing feature is that the block of ore between Nos. 3 and 4 levels was one of the best in the mine, and some very fine ore was exposed in the winze on the day of my inspection. The total amount of ore crushed at the Company's works, taken from official returns, is 8,276 tons crushed for 265.75 tons of tin oxide, valued at £22,541. At the present market price this would be worth approximately £29,760, or £3 6s. per ton of ore treated.

The Cassiterite mine is equipped with an up-to-date tin-dressing plant, and is eminently suitable to the present requirements. Starting from the ore bin, which has a live capacity of some 40 tons, the ore gravitates on to a floor, and is hand-fed into a 14in. jaw cracker of the Blake type. From here it feeds through a set of wet crushing rolls, built by May Bros., Sydney, N.S.W. The diameter of the rolls is 2ft. 6in. with a 15in. face. The capacity of the rolls to about 1/8 inch mesh, is three tons or more per hour. After passing through the rolls the crushed product gravitates through a revolving trommel 4ft. by 2ft. 6in., 6 feet long, and with a ½ inch punched screen. The returns from the trommels are sent back to the rolls with a small bucket elevator. All the screenings from the trommel are then passed into a May jig, provided with 10 Spitz Kastens. The effective screen area of the jig is 13 feet (17 feet over all), that is a screen area of 52 square feet. Screens 1 inch mesh. The jig has eight plumpers, length three feet, width 12 inches, throw three inches.

Roughly speaking, according to the manager's figures, 75 per cent. of the ore passes over these jigs to the dump. Of the product from the Spitz Kastens under the jigs, the first four are classed as "concentrates," the second as "middlings," and the last two as "tails."

The product from the first four, the concentrates, gravitate to a Wilfrey table, the tails from which pass out to the dump, and the concentrates and middlings are hand-fed into a "6ft." Huntingdon mill.

BULLETIN E CA HANNERMANN'S SHAFT



The middlings from the jig gravitate into the same mill and are re-ground with the concentrates and middlings from the first Wilfrey.

All the re-ground product of the Huntingdon mill gravitates on to a second Wilfrey table and is re-concentrated, the tailings from the second table going direct to the tailings dump, and the middlings returned to the Huntingdon mill by hand, and the concentrates bagged for shipment.

A 65 h.p., called 70 h.p., Diesel oil engine developes the power to drive the whole plant. The oil used is the crude mineral oil, and is imported from Singapore, where it costs 7d. per gallon, and 2s. per gallon on the mine. The extra cost embraces duty, freight, leakage, return of empties, etc.

As the horse power per day probably averages about 40-50 constant, and the consumption of oil is 36 gallons for the 24 hours, this works out at about 1s. 6d. per horse power per 24 hours, or 45s. per horse power per month of 30 days, reckoned at 50 horse power, which is a little higher as compared with the results obtained from the gas-producer engine, allowing for the increased cost of charcoal, £7 to £8 per ton.

When running full time the plant is capable, under the existing arrangement, of crushing 75 tons in 24 hours.

The water supply is obtained from two wells, one near the mine, and the other on the flat, westward, distant about half a mile. Electric power is transmitted from a 16 h.p. Sieman's generator at the mine to these two wells and the pumps driven with a 5 to 7 h.p. motor.

Unfortunately, the water supply from both wells is not sufficient to run the whole plant constantly for more than eight hours per day, but this could probably be remedied by deeper sinking.

With regard to the other tin lodes on the eastern side of the range, the only one being worked at the time of my inspection was the "Tin Stone Mine," but as the prospectors were working more with the object of obtaining pocket tin ore this mine is scarcely worthy of notice at the present juncture. My inspection of the eastern belt convinced me, however, that there are numerous pegmatite dykes, and offshoots from the same, carrying more or less tin, but up to date they have not been prospected with the view of obtaining low-grade ore for crushing purposes, but have been picked over with the object of obtaining patches of rich ore suitable for bagging and direct shipment. Further reference to the tin ore of this belt will be made later on in this report.

In addition to the tin ore deposits on the Eastern belt, important discoveries of tantalite and radio-active minerals were made on M.L. 86, H.M., and M.L. 87, Anchorite. The tantalite and radio-active minerals occur in a pegmatitic dyke which traverses these two leases from end to end. Most of the tantalite has, so far, been won

from alluvial deposits, the apparent sheddings of the lode. About the centre of the two leases a shaft has been sunk on the lode a depth, on the underlie (45deg.), of 75 feet and a horizontal crosscut 44 feet driven to the westward. A section of this crosscut, commencing from the eastern wall, shows four feet of solid albite felspar, 28 feet of pegmatite granite, and 12 feet of solid albite felspar. The tantalite occurs almost exclusively in the four feet of albite on the hanging wall on the eastern side, bunches of tantalite being visible in the wall of the shaft, the radio-active minerals are found in the albite on the footwall side, but here tantalite is absent. Where the radio-active minerals are found the felspar usually shows up a brown colour, and such colouration is known as the "indicator." The colouration is probably due to iron oxide derived from the decomposition of small quantities of ore of the radio-active minerals, for the colouring matter is undoubtedly oxide of iron.

Considering the commercial price of these rarer minerals, it seems a pity to see this mine in its undeveloped state, but, as the owners state, mining is an expensive process in Wodgina, and the market for tantalite uncertain. Unfortunately, too, the footwall of the lode is "frozen" on to the country, and is not like the hanging-wall, which comes away "clean," and leaves a most perfect face on the country rock. This, of course, would make driving on the footwall, where the rare minerals occur, still more expensive.

In connection with the general occurrence of the lode, it is worthy of notice that in the northern end of M.L. 86 there is a preponderance of lithia mica, also the spheroidal mica, exactly similar to that found on the Eastern goldfields in the acid dykes at Londonderry and Ubini, where tin and tantalite have been found in small quantities. It would be worth while for prospectors, when working in districts where either of these rather rare rock-forming minerals, pink, blue, or spheroidal mica occur, to send in any bright vellow or heavy black minerals they may happen to find for determination, or at least, when opportunity offers, to inspect samples of such minerals in the Survey or other collections. I refer to the minerals Pilbarite, Thorogummite, Mackintoshite, worth at present some £700 per ton. If there was any steady demand for tantalum there is no doubt that large quantities of tantalite could be won from this lode, for the mineral shows up in bunches and veins in the outcrop and shallow workings throughout the length of the two leases.*

The Western Lodes.

About three and-a-half to four miles due west of the "Cassiterite" mine massive granite forms the country rock, the intervening rock as pointed out by the Government Geologist in *Bulletin* 40, being crushed, sheared, and otherwise altered greenstones.

^{*} For geological features see Bulletin 40, pages 273 on, and page 368.

Along the junction lines of the granite and these greenstones, extending for some considerable distance at times from the granite, are numerous granitic or pegmatite dykes. The prevailing strikes of these dykes is north and south (approximately) with a general easterly underlie; usually they are of no very great width, varying from a few inches up to perhaps 30 to 40 feet. Lithologically, they vary from almost pure quartz to coarse grained pegmatite, the prevailing rock-forming minerals, mica and felspar, often replacing one another almost completely, though at times they are regularly distributed, or in layers or bunches. There appear to be several varieties of felspar, though the albite variety predominates. Of the micas, the brown (biotite) and white (muscovite) predominate, but the pink (lepidolite) variety is of common occurrence. Tourmaline as a rock-forming mineral is not at all uncommon, and small red garnets are often to be seen throughout the whole mass. The greenstones are much crushed and altered, especially near the massive granite, where in some instances they resemble a mica schist so closely that they may be classed as such.

Jennings and Child's Lease.—Commencing on the northern end, the first M.L. from which tin has been won has been worked by Messrs. Jennings and Child. A small crosscut into the side of the hill exposes a pegmatite dyke, which, apparently, strikes west 25 deg. east, and underlies east. The underlie, however, is doubtful, also the width of the lode. A small heap of about two tons was broken ready for treatment, and showed nice payable tin contents. The lode is ordinary pegmatite, with streaks of hornblende and tourmaline throughout with which the tin oxide appears to be closely associated. A well defined outcrop can be traced for a considerable distance to the south-west and for some distance to the north-east. Except that tin occurs in payable quantities in the one place opened out, there is no further information to be gleaned from the workings on this lease.

Wilson, Houston, and Oswald's Lease.—This lease has been pegged out on a dyke running parallel to the one worked by Messrs. Jennings and Child, but about 20 chains to the westward. Two small trenches, not more than eight feet deep, have been put down in the lode, from which 20 tons of ore was taken and crushed for a return of four-and-a-half per cent. tin oxide, reckoned 70 per cent., i.e., equivalent to £4 10s. per ton approximately. Neither of the trenches have reached the walls of the lode, which must be at least more than 10 feet wide, but as the outcrop is covered over with detritus the true width is not obtainable. This dyke, like the others, is pegmatitic, but has a considerable amount of the lepidolite mica distributed throughout. The tin is seen occurring throughout the lode though the major

part is in the footwall portion. As far as their trial parcel which was sent to the mill is concerned, there could not have been much picking of this, unless some rich bunches of tin ore were included, which could raise the percentage extraction to almost any degree; but after all, if such were the case, it is still a portion of the lode, though usually kept separate on account of its erratic occurrence. The lode extends south, and into the Carbine extended.

Carbine Extended No. 1 Lease.—The wall being worked on this lease is a southern continuation of the one worked in the Wilson, Houston, and Oswald's mineral lease. At present only the cap of the lode has been broken in one place by means of a trench across the direction of the strike. In this trench the footwall apparently has been exposed, but no hanging wall; and as the outcrop is hidden the true width is not at present ascertainable, though it is at least 12 to 15 feet. Scattered throughout the stone is apparently a sprinkling of fine tin, but what the percentage is I was unable to ascertain. A little further development, however, in this and other spots along the strike would soon show the values, for the top of the dyke is no great distance below the surface.

Carbine Lease.—The lode opened out on this lease is probably a parallel lode to that on the Carbine Extended, or, possibly, the same faulted to the westward. As in the Carbine Extended, sufficient work has not been done to even ascertain the true dip, strike, or width of the lode. Some rather nice ore, however, has been raised, three tons of the same being on the surface ready for treatment. This lease was not being worked on the date of my inspection.

Raney and Hall's Lease.—To the immediate south of the Carbine is a mineral lease held by Messrs. Raney and Hall. The workings are on the side of the hill, and are, probably, a continuation of the Eastern lode worked by Messrs. Jennings and Child. Only a limited amount of work has been done, but such has revealed a large body of tin-bearing ore, 20 tons from which gave the return of one and a-half per cent. tin oxide, equivalent to 30s, per ton at present market prices. From close observation, it does not seem probable that this trial crushing was picked to any appreciable extent. I consider that there is a possibility of obtaining large quantities of low-grade ore from this mine, if it were opened out to any extent. The lode itself is similar to the others described, except, perhaps, it is more compact and harder, is closer grained in texture, and has less mica present. The tin oxide is very fine and this would probably give a higher residue with coarse crushing than usual. The felspar throughout the lode is

often of a light pink colour, the exact nature of which has not as yet been determined. There are about 20 to 25 tons still lying at grass, but of too low-grade for treatment under existing conditions.

Referenda Lease.—About one mile to the south of Raney and Hall's lease and some half-mile south of the Government Well, a small gully was worked for alluvial tin with considerable profit. It is reported that at least five tons of oxide was bagged from this source. On the alluvial being stripped a pegmatite dyke was found under the wash, but so far tin oxide has not been found in payable quantities in this dyke. By following the alluvial deposit up the slope of the hill, however, the origin of at least some of it was discovered and in the past few months McGuinness and party have recovered upwards of three tons of oxide. The occurrence of the tin oxide here is similar to the other lodes already described. At present the only workings are some trenches extending over a total length of about 120 feet. In the north end of these workings the lode is about six feet wide and underlies to the east at an angle of about 45 deg. Here rich ore was found on the footwall side of the lode, but little, if any, in the lode itself, and about 40 feet south from this point the lode was lost. Further on, however, the lode was found again, and though massive is much broken up; the strike, however, is the same as the northern portion, and there seems little doubt of their being one and the same lode. In the southern portion a little massive tin oxide was found just beneath the surface on the cap of the lode with a good patch of ore right at the surface.

A nice vein of ore was worked also in the centre of the lode, but this has cut out for the time being. The characteristics of the pegmatite vein are the same as those already described. Immediately to the westward is a band of tourmaline rock. A few chains up the hill to the eastward, another parallel pegmatite dyke may be seen outcropping, but so far this has not been prospected.

I consider it more than likely that these lodes are a continuation of the lodes to the north, or at least they are a continuation of the same fissures.

Half a mile south of the Referenda mineral lease, a series of quartz reefs outcrop with a north by east strike, and an underlie to the east. These reefs contain variable quantities of scheelite. This mineral is also found in the mica schist encasing the reefs, and in all, can be found extending over a width of from 20 to 30 yards. No work has been done on this property with the exception of a few shallow trenches, which do not reveal much, except that the scheelite occurs in bunches throughout the quartz and schist. It is very difficult to gauge the value of this discovery, but it certainly warrants the expenditure of capital sufficient to sink a shaft, and crosscut the formation, say, at 100 feet. There is no

doubt that on the surface the indications are that the formation is large, but as to the percentage of the mineral present, one cannot form even the vaguest idea.

The present market price of scheelite is 31s. per unit, scheelite being reckoned commercially as containing 65 per cent. WO₃.

The Stannum Group.

A group of several tin leases lies about eight miles South-West of Wodgina proper, and the same distance from the Referenda Tin Lease. This group is known as the "Stannum Group," of which a full description is to be seen in the Government Geologist's report, Bulletin 40, page 269, et seq. Since his inspection, there has been no development worthy of notice.

Four miles further south, *i.e.*, 12 miles from the "Referenda," is "Siffleete's Claim." This lease contains several parallel pegmatite dykes running more or less north by east with offshoots trending more or less east and west. The dimensions of these dykes are unknown as the prospecting so far has consisted in picking over the surface and working out the footwalls of the dykes in which apparently most of the tin oxide appears disseminated in fine particles throughout the stone. There is no doubt that the dykes extend for considerable distances on the surface, and that some nice patches of tin ore have been found. In all 11 tons of tin ore have been won from this lease.* A trial parcel of 20 tons yielded 13cwt. of tin oxide at the Cassiterite Mill.

Bright Star Mine.—This mine is approximately eight miles south of Siffleete's. The whole area is a network of granite dykes, with a prevailing north-east and south-west strike and a westerly underlie. A shaft has been sunk on two offshoots of one of the largest of these dykes to a depth of 20 feet on the underlie and a crosscut driven a few feet into the main dyke. A fair amount of oxide is visible in the faces of the dykes exposed, but mostly in the Some 100 feet to the westward of the above workings another shaft has been sunk on a parallel dyke to a depth of about 25 feet on an underlie of 45° west. This lode is practically quartz and felspar with accessory mica and garnets. and is six feet thick at the top of the shaft and three feet thick at the bottom. A short drive has been started towards the north from the bottom of the shaft. A fair amount of tin is visible in the stone particularly on the footwall side of the lode. The country rock is probably crushed greenstone, but some of it on the walls is nearly pure black mica. I could not obtain any definite returns from crushings taken from this mine.

Ede Emma Lease.—About three miles west from the "Bright Star" Tin Mine and practically on the end of the range is the "Ede Emma" mineral lease. Mining operations have been

^{*} Returns gained from Mr. Siffleete.

carried on here to a limited extent in opening out three pegmatite dykes. The main one of these strikes north-east and is intersected near the workings by one striking north 15 east. About 150 feet from this intersection a cross vein connects the two, thus forming the letter A. Of these, the most important tin-bearer is the first, which has a thickness of about eight feet where exposed, and dips at a low angle to the east. Coarse tin is found occurring as usual on the footwall side of the lode for a thickness of about 12 to 18 inches. The lode is a pegmatite dyke, containing coarse felspar and quartz with a fair percentage of lepidolite (pink) mica.

The second dyke is a large pegmatitic one, traceable on the surface for a great distance. So far this one is unprospected, and whether it contains payable tin or not has not yet been demonstrated. Coarse tin is found in the cross dyke, but it is only a few inches wide and has no great length.

In addition to the mining operations already described there are numerous other minor ones in places where tin has been discovered, but the lodes have apparently not been rich enough to encourage the prospectors sufficiently to induce them to continue work.

Both in this locality and further north, the country may be said to be gridironed with pegmatite dykes, the majority of which are stanniferous to a greater or less degree.

At the end of the range, a little north of the "Ede Emma" M.L., one of these dykes carries a fair amount of tantalite on the surface, and in association with it are distinct traces of thorogummite and mackintoshite, the radio-active uranium minerals, found in the tantalite leases at Wodgina proper.

General.—In dealing with the question of helping the prospectors at Wodgina, it is necessary to take several local conditions into careful consideration. The field is isolated from communication; roughly, it is 70 miles from a railway, fuel and water are scarce, mining timber extremely expensive, rate of transport exceedingly high, and crushing facilities scarce.

Probably of these, the two which affect prospectors more than all the others, and yet can be the most easily rectified, are transport and crushing facilities. Up to the present, and more particularly on account of these last two difficulties, the prospectors have sought for the high-grade ore which could be treated by dry blowing and sifting on the ground. Low-grade dirt was practically of no use to them whatever, and was not sought for. One cannot imagine a worse state of affairs from a mining point of view, unless it be not to prospect at all.

The question is how to rectify this state of affairs, and to find the means whereby to do it.

From a perusal of the reports in *Bulletin* 40, and the preceding pages of this report, it is evident that a large number of tin-bearing lodes are scattered over an area about 20 miles long at least, possibly nearer 40, and anything up to four miles wide. Trial crushings from these have proved that the ore is payable under favourable mining conditions.

The surface of this area is about as rough as one can imagine, and almost impossible for vehicular traffic. Transport of ore by pack camels from low-grade propositions over almost any distance however short is prohibitive when one considers that it means, not only the hire of camels, but necessitates purchase of bags, hand breaking of ore, to pack in bags, sewing bags, loading and unloading, etc. Hence it is an impossibility to place a plant which would serve all the field, for if tin mining is to be a success at Wodgina it will be low grade if anything. The Eastern group of mines are on the whole, on the sides of precipitous hills, and, as a rule, near the top. To get the ore from these to the bottom of the hills it is almost imperative to handle it in bags, unless flying foxes, etc., were erected, and when once bagged and handled it might just as well be taken to the Cassiterite Mine as anywhere else. For the Eastern belt, therefore I suggest that the Cassiterite mine owners be approached for reasonable crushing terms. If it is decided to erect a stamp battery to help the prospectors of the Western and Southern groups, I would have no hesitation in recommending a site somewhere to the immediate north of the Referenda. A battery on this site would certainly tend to prove whether low-grade tin ore can be made payable, for the mines in this portion of the Western group are close together at the base of the hills, and the ore could be carted for probably 1s. or 1s. 6d. per ton right to the battery from any individual mine. It was suggested to me that a site between the Referenda and Siffleete's would be a suitable one; such would necessitate an eight to twelve miles carting for everyone except one or two mines at Stannum and Siffleete's. I cannot see that such would attain the object the erection of a State mill would have, and consider it would be far preferable to try the experiment under the best conditions, and if such were a success further expenditure could be undertaken at a later date. Apart from this the ore could be carted from several mines in the South, in fact from any from which it would be carted, to a central site. This in itself would be a distinct improvement on present conditions for the Southern leases.

I cannot suggest any cheaper method for carrying stores to this mining centre than the ones already in vogue, viz., packing on camels or carting by team.

Summary.

There are numerous tin-bearing lodes of different commercial value in and about Wodgina extending over an area of from 20 to 30 miles long by four miles wide.

With one exception none of these lodes have been opened up to a greater depth than 25 feet.

From a geological point of view there is every reason to believe that the lodes will continue to such a depth as they are ever likely to be followed.

The one mine which has been worked on a large scale has produced £26,000 worth of tin, which was sold at much below the present market value.

At the time of writing the prospector at Wodgina has no encouragement to prospect for low-grade ore, but is forced by circumstances to confine his energies to searching for pockets of ore and stone rich enough to treat by hand on the ground.

What is hindering development at Wodgina more than anything else is high charges for transport and absence of crushing facilities, and, to a lesser degree, scarcity of water.

As the trial parcels of 20 tons, crushed free of charge to the prospector at the Cassiterite mill have all proved payable under favourable milling conditions, it seems highly probable that large quantities of low-grade tin ore would be found if such conditions were permanent.

I would recommend:—(a). That the Cassiterite mine owners be approached for reduced crushing charges for the Eastern group of leases; (b) that a small crushing and concentration plant, such as the Government mills at Greenbushes, be erected for the Western group of leases; (c) that the site for such be in the northern end, in the vicinity of the Referenda M.L., or the Carbine M.L., the exact locality depending on the water supply.

As regards sinking for water, any of the gullies along the western side of the ranges should be suitable sites for bores, more particularly if the borehole is made to the eastern side of one of the hard "bars" outcropping with great frequence along the whole belt.

I would suggest that boring parties of the Goldfields Water Supply Department have a free hand in choosing the exact spot for this work.

Table showing the Production of Tin Ore from the Wodgina Tinfield.

Year.	Name of Mine.	Ore Crushed.	Tin Oxide.	Total Value.
1907 1908	Mt. Cassiterite Do	tons. 1,744 92	$ \begin{array}{c} \text{tons.} \\ 91 \cdot 60 \\ 18 \cdot 50 \end{array} $	£ 8,961 1,413
	Total	1,836	110 · 10	10,374
1907	Mt. Cassiterite North	10	3.55	328
1908 1909 1910 1911 1912	Mt. Cassiterite Leases Do. do. (Do. do. Do. do. Do. do.	2,431 2,149 1,740 110	$\begin{array}{c} 12 \cdot 50 \\ 75 \cdot 00 \\ 4 \cdot 00 \\ 31 \cdot 75 \\ 26 \cdot 85 \\ \cdot 50 \\ 1 \cdot 50 \end{array}$	812 5,250 280 2,343 2,924 50 180
	Total	6,430	152 · 10	11,839
1912	Wodgina Queen, M.L. 203	20	•90	108
$1912 \\ 1912$	Comet, M.L. 192 Siffleete's Reward, M.L. 178	15 20	·30 ·70	36 84
1912	Raney, P.A. 279	20	·30	36
	Grand Total	8,351	267 · 95	22,805

The above returns have been obtained from official records. They are undoubtedly low, but this is purely the fault of the prospectors and others who have failed to send in the records of all the tin they have won to any of the Government officers authorised to receive and tabulate such.

From Wodgina *en route* to Balla Balla we passed over granite country to Yandearra station. Owing to the heavy rains the roads were particularly heavy, and the crossing of the Yule River almost impossible except for light traffic.

Past Yandearra to Mallina and on to Balla Balla the country, with the exception of a narrow granite belt, is of the prevailing types of rock met with in the Nullagine Series and consists of much altered sediments.

At Balla Balla the Whim Creek copper mine is being worked on a large scale and forms the mainstay of the district from a mining point of view. A full geological description of the mine and surroundings is to be found in *Bulletin* 41*, and need not be re-

[•] By H. P. Woodward, Bulletin 41, Geological Survey, W.A.

peated. Comparatively little development work has been done since this report was written, the mining operations up to the present consisting principally m looking for and working out the rich lenses of ore for shipment purposes. It is pleasing to note, however, that a large concentrating plant involving the Murex Patent is being installed which, it is expected, will enable the mine to treat a much lower grade of ore than formerly. Briefly, the principles on which this treatment depend are as follows:—

The ore is first crushed with rolls and mixed with a variable percentage of water about one to one by weight. This mixture of crushed ore and water is then passed into agitators into which are dropped variable quantities of a mixture of crude oil and finely crushed magnetic iron ore. It is affirmed that the concentrates, whether they consist of sulphide, oxide, or carbonate copper ore, adhere to the oil mixture. After the agitation process is complete the total product is passed over flat tables and flows under strong electric magnets, under which an endless tape is constantly passing. The magnet attracts the magnetic iron ore, and in consequence the adhering concentrate, holding it up to the underside of the revolving tape until it passes over the side of the table where the magnetic attraction ceases and the concentrate falls into a receiver. It is claimed that an 85 per cent. extraction can be obtained by this method. The whole plant is driven by a 500 h.p. compound producer gas engine, the largest of its kind in the State. The oil for the treatment is obtained from the "East," but the magnetic ore is got by roasting and grinding iron ore obtained locally. If this plant comes up to expectations it will certainly become a big factor in copper ore treatment in this State.

THE WHIM CREEK COPPER MINE.

In accordance with verbal instructions to inspect the Whim Creek Copper Mine, with the object of ascertaining the present condition of the mine as regards the "Mines Regulation Act," the following report was submitted:—

Underground mining has been carried on by irregular and unsystematic methods, the ore being extracted from chambers the roofs of which are left unsupported except at the sides. The primary reason of this method of mining being adopted is due to the erratic nature of the ore deposit, the payable ore being found in lenses and pockets, and not as a continuous ore body.

Where possible, pillars of unpayable ore or country rock are left as supports, but as the extent of the lenses of payable ore is variable, the distance between the supporting pillars varies more or less with the size of the lens of ore. Fortunately the roofs of the chambers from whence the ore has been taken is splendid holding ground, and, so far, accidents have not occurred, but I wish to draw attention to the fact that the stoping is now approaching the

water level, and I do not consider this form of mining will be safe in wet ground unless precautions are taken. In addition, there are two open chambers at the 60 feet and 80 feet levels which I deem to be far too wide and long to be safe. Their great height too prevents careful inspection as to whether the roof is scaling or not.

The attention of the manager has been drawn to these two stopes, and I have forbidden their use temporarily, for though men are not mining in them at present a tramline was running through one in which men were trucking ore at the date of my inspection. In all other places on the mine the men, so far as I could ascertain, were working in safe faces.

The ventilation throughout the mine was good except in one or two "dead ends," but this should only be temporary.

On the surface I have to report there was no record book at the mine on the day of my arrival, the excuse being that the book in use had been destroyed by fire some week or two previously. The following morning one was produced, but it was of no practical use to any inspector.

In consequence there was no record of testing of cages, ropes, safety hooks, etc., or of any objections which may have been made during the last two years.

As the mine is probably about to be worked on a much larger scale than formerly, I have no hesitation in recommending that an Inspector of Mines be sent periodically and at short intervals to investigate the working conditions on this mine, also that copies of the working plans be forwarded to the Mines Department in Perth as the law requires.

From Whim Creek to Roebourne the country is for the most part flat, and consists of the coastal plains overlying granite.

ROEBOURNE.

There was a certain amount of mining activity, mostly in search of copper, on account of the rise in the metal market, the quote for electrolytic copper being £78 per ton.

Geologically the Roebourne mining centre is situated in a small area of basic igneous rocks surrounded by granite on the south and the altered sediments on the north. Gold mining was practically at a standstill, and as no fresh developments had taken place since a lengthy report was written on the district by the Assistant Government Geologist, Mr. Woodward, Bulletin 41.* I confined my attention principally to the copper mining of the district.

With the exception of Whim Creek and one undeveloped mine, the occurrence of copper throughout the Roebourne district consists invariably of small, short shoots, occurring in ore channels in the basic greenstones. Some of these shoots contain at times high copper values, and in one instance high values in gold.

The following are descriptions of the various copper mines in operation at the time of my visit:—

Fortune Copper Mine (64 old number), since re-pegged and applied for. A full description of this mine is given in Bulletin 41,† and since the date of the writing of the report contained therein little if any work has been done until quite recently. At the time of my inspection a party of men were doing some development work at shallow depths along the lode, but no attempt was being made to test the ore channel at depth. Mr. Woodward's report is a concise description of the mine as it appeared to me.

An old abandoned copper mine called the *Azurite* lies about one mile north of the "Fortune." The lode in this mine runs east and west with a straight underlie to the north. A shaft with a vertical depth of 36 feet and a shallow open-cut 50 feet long extending west from the shaft are the only workings on the lease. The country rock consists of a coarse gabbro rock. The ore channel is narrow, and the lode ore of the short narrow shoots typical of the locality. Official records of the ore taken from this mine are not procurable.

Some 15 chains to the south of the Azurite mine is a small lode striking east and west. A sample taken from a heap of sulphide ore lying at grass near the shallow workings yielded a return of copper 12.85 per cent. and gold 2dwts. 2grs. per ton. The lode, though narrow, gives some promise of length and probably extends into what is known as the Yankee's claim, distant about 15 chains to the westward. Microscopic examination of samples of the country rock tends to prove it is a gabbro, intruded in several places by dolerite. Apparently the rock has been considerably fissured during some period of its history, for there are indications of several lodes similar to the above-described in the vicinity.

The Lily Blanche Mine.—This mine, which has produced the most copper up to date, was closed down and inaccessible.

Next in importance in the production of copper is the Carlow Castle group, including the Quod Est, which also carries considerable gold values. In *Bulletin* No. 41, H. P. Woodward, Assistant Government Geologist, describes in full the lodes and workings on the Carlow Castle Mine; as most of these were inaccessible to me, his full description is quoted as under:—

The first mining operations conducted in this district were at the Six-Mile, now known as Glenroebourne, where two lodes were opened up, the one upon the northern side of the valley, known at the time as Cooper's but recently as the Carlow Castle, is reputed in the "eighteen-seventies" to have yielded a considerable quantity of ore, which with that raised from a lode upon the south side of a valley from what is known as the Fortune, by one called Tin-ribs Wilson, appears to have been despatched by sailing vessel as ballast to wool, thus no manifest appears

to have been made out, and therefore no Customs entry. The above information was furnished by Mr. F. Pearse, J.P., who was at the time a partner in the firm of F. McRae & Co., of Roebourne, through whose hands the ore passed.

In the Annual Report of the Government Geologist for 1888 it is stated:—

A few miles south of Roebourne some copper mines were worked a few years ago. They are situated at the base of some low slate and quartzite hills on the edge of a large flat formed by one of the branches of the Harding River. The ore is chiefly ferruginous oxide of copper, whilst in that from one shaft gold was visible. There are two series of lodes, one of which striking more or less north and south with a dip to the east, the other running east and west with an underlay to the north. A good deal of work has been done upon them, but has been discontinued owing to the low price of copper, but now that the market value of this metal has improved these mines should be re-opened, since the quality of the ore at grass is good and the distance from port short. In any case the ore contains gold, which should pay working expenses, since this metal is now allowed for in the purchase of ore.

The Carlow Castle Mine, M.L. 65.—The northern group of lodes originally worked for copper lies close to the south side of a rough range formed of laminated quartzites, which strike in an east and west direction, the country rock upon either side consisting of schistose dolerite. These were first taken up under six gold mining leases, but they have long since been abandoned, whilst, with regard to their production, no record exists. A portion of this area, including Cooper's old workings, were taken up in 1898 as a mineral lease under the name of the Carlow Castle, from which, according to the files of the "Northern Public Opinion," two shipments of ore were despatched, the first of which was nine tons, which gave a return of 31 per cent. copper and 3dwts. of gold, and the second, 1½ tons, yielded 16 per cent. of copper and 1½ ozs. of gold.

The same paper stated that in February, 1899, the mine was sold for £32,000, but in the month of July work ceased owing to the influx of water.

A small syndicate of Roebourne residents appear to have worked the mine in 1900, when about 20 tons of ore, assaying 30 per cent., were bagged and shipped, whilst in February, 1901, 30 tons of ore were sent to Adelaide and Fremantle for treatment, which yielded 24 per cent. of copper and 14dwts. of gold per ton. It will be noticed that these statements are very conflicting with the official return shown in the tabular form below.

In 1907 the ground was again taken up and transferred to the Roebourne Copper and Gold Mines of W.A., N.L., in whose interests it was worked during that year and thereafter abandoned. It was again, however, taken up in 1909 by Messrs. Shaw and party, but, although they were raising ore for shipment in July 1909, no record appears regarding it in the official statistics.

There are eight distinct lodes upon this lease, which present considerable variety in both strike and dip, whilst the enclosing rock is a schistose dolerite.

No. 1 lode is situated in the north-west corner of this lease, at which point it can be traced for a distance of ten chains, running from the western boundary across the corner diagonally in a northerly direction, and so into the Q.E. lease, which lies to the northward. This has been followed down to a depth of 70 feet, with a little driving at the 50 feet level, the winze-like shaft having apparently followed a pipe of ore about eight feet in width that pitches to the south down to water level. Judging by the large paddock of low-grade silicious ore at the surface the rich portion bagged must have occurred in small veins. This lode has also been opened by two pits further north, and an underlay shaft some 30 feet in depth, in which the ore-body, consisting of ferruginous oxide and carbonate of copper, is between three and four feet in width and dips to the eastward.

No. 7 lode lies a little to the south-east of the last-mentioned. It strikes in a north-easterly direction, having an underlay to the south-east. It outcrops for a length of five chains, and has been tested by two or three small shafts and some trenches, in which the lode matter exposed consists mainly of quartz, containing a little green carbonate of copper.

Due east of this, and situated at about the centre of the lease, is the No. 2 or main lode, which strikes almost north and south with an underlay to the east. Upon this a considerable amount of work has been done, the ore being apparently raised from a number of shafts and open-cuts along the outcrop for a distance of eight chains. A main working shaft has been sunk, but owing to the removal of the timber from the collar it has now fallen in. The lode is said to have averaged about four feet in width, and to consist of quartz, containing iron and copper oxides, malachite, and native copper, the ore upon the whole being rather silicious.

No. 3 lode, which is situated at the north-east corner of the lease, outcrops in a north-westerly direction for a distance of about four chains, having an underlay to the south-west. Several shafts have been sunk upon it, one below the water level now being used as a well. This lode appears to have been upon the whole small and of rather low grade, with rich bunches or wall concentration, whilst below the water level, in the sulphide zone, it contains a certain quantity of nickel and cobalt, an assay of two samples of which gave 1.00 and 1.87 per cent. of cobalt and .45 and .67 of nickel respectively.

The other four lodes are of little importance, being of short length and low grade.

Table showing the Yield of the Carlow Castle Copper Lode.

Year.	Name and No. of Lease.	Ore smelted.	Copper therefrom.	Assay value.
Prior to 1899 1899 1900 1907 1907	Carlow Castle, M.L. 14 Carlow Castle, M.L. 14 Federation, M.L. 42 Carlow Castle, M.L. 65 Roebourne Copper and Gold Mines of W.A., N.L., M.L. 65	tons. $85 \cdot 00$ $48 \cdot 00$ $26 \cdot 00$ $6 \cdot 00$ $81 \cdot 00$	tons. 18·27 11·58 6·24 1·00 *19·88	per cent. 21·50 24·12 24·00 16·66 24·54
	Total	247 · 00	56.97	23 · 15

* $28 \cdot 35$ ozs. of fine gold.

Since the above report was written the south shaft on No. 1 lode has been extended to a vertical depth of 80 feet and follows a shoot of copper to the water level.

A sample taken across the lode at the bottom of the shaft gave the following results:—12.74 per cent. of copper and 2dwts. 4grs. of gold per long ton for a width of 10 feet. There was a good deal of pyrites showing in the face, and a sample of this was taken for assay and yielded 0.62 per cent. of copper only. On the footwall side of the lode some nice bunches of ore, containing the black copper oxide, yielded 24.34 per cent. of copper and 1 dwt. 2 grs. of gold per ton.

Experiments were carried out with the object of ascertaining whether the ore was amenable to concentration. The following is the result:—

Assay of original ore.—Copper, 12.74 per cent.; Gold, 0ozs. 2dwts, $4 \text{grs} = \cdot 108 \text{oz}$, per ton.

Weight of Concentrates—62.90 per cent.

Assay of Concentrates.—Copper, 14.83 per cent.; Gold, 0ozs. 2dwts. 4grs. = .108ozs. per ton.

Distribution of Original Ore Values.

Concentrated—Copper, $9\cdot 32$ per cent.; Gold, $\cdot 068$ ozs. per ton. Tailings.—Copper, 3.42 per cent.; Gold, $\cdot 040$ ozs. per ton.

Taking 100 tons of broken ore and adjusting on the above figures, the following would be the differences in realisation between concentrating on the spot and shipping the whole direct without any sorting and not allowing for concentrating cost:—

Ore.	Concentrates.	Tailings.	Assay value— Copper.	Total Copper contents.	Gross value.	Market price of pure Copper (nominal).
tons. 10	tons. 62·9	tons.	per ton. 12.74 14.83	tons. 12·74 9·32 3·42	$\begin{array}{c} £ \\ 1,019 \cdot 20 \\ 745 \cdot 60 \\ 273 \cdot 60 \end{array}$	£80 per ton do. do.

On a typical parcel of ore shipped from the Q.E. Copper Mine to Kembla Smelter, N.S.W., the following are the charges:—

5.4696 tons gross weight.

5.3603 tons net weight.

Copper percentage 16.7.

Returning charge 1.3.

Percentage of copper allowed 15.4—ou parcel, .8254 tons by smelters.

.8254 tons at £57 8s. 2d	57	s. 8 10	2
Gross Return	94	18	7
Returning Charges—			
82.54 units at 4s. 3d		10 10	8 7
	£18	1	Б
		7.4	
Freight, Sydney Agencies, etc			
Kembla Wharfage		6	
Sampling Fee	1	1	0
From mine to boat at Roebourne Jetty	y 7	11	3
Total Expenses (not including mining)	£38	15	6

Net Return .. £63 14 4

and total cost per ton £7.

Taking £7 as total cost for realization of copper contents and applying this to the Carlow Castle bulk ore, neglecting the gold contents, which are not high enough to warrant consideration, we find that if the ore was concentrated a saving of $37.1 \times £7 = £259.7$ total cost would be effected as against a loss of £273.60, price of copper contained. These figures do not allow for the cost per ton for concentrating.

If the sulphides that are coming in at the bottom of the workings continue low grade, this will tend to still further condemn concentration, unless the sulphide concentrates be rejected and the tailings are rich enough for shipment, really a deconcentration proposition.

On the Quod Est Mine, which adjoins on the north, a similar shoot of copper ore occurs on a continuation of the No. 1 Carlow Castle lode. The shoot in the Quod Est Mine dips to the south with a slight underlie to the east.

Except for the following of the shoot of ore to the 100 feet level by means of a shaft and one or two very short drives on the

lodes at the 80 feet and 100 feet levels, no development work has been done on the lodes in this lease. In consequence, there is practically no ore developed in the mine though there are several hundred tons of seconds on the surface.

From these seconds about 300 tons of shipping ore has been taken which has yielded a gross value of £4,400, or roughly, a return of £15 per ton.

For a concentrating proposition, the ore in this mine is not in any way suitable, the following results being obtained from a bulk sample taken from across the face of the lode in the bottom level and concentrated by hand panning.

Percentage of total Copper Contents in Concentrate . . 40
Percentage of total Copper Contents in Tailings . . 60
Percentage of total Gold Contents in Concentrates . . 60
Percentage of total Gold Contents in tailings . . 40

Samples from the Quod Est and Carlow Castle mines were found on analysis to contain the following percentages of base metals:—

	Mineral.				Quod Est Mine.		Castle. ine.
Copper Cobalt					$\begin{array}{c c} \text{per cent.} \\ 12 \cdot 80 \\ 1 \cdot 63 \end{array}$	per cent. $\begin{array}{c} 4 \cdot 24 \\ 1 \cdot 00 \end{array}$	per cent. 4.00 1.87
Nickel Arsenic		••			·13 ·86	$\begin{array}{c} \cdot 67 \\ 2 \cdot 76 \end{array}$	$\begin{array}{c} \cdot 45 \\ 7 \cdot 35 \end{array}$

A pink mineral found on the Quod Est mine and kindly presented by Mr. Smallpage has been reported on by E. S. Simpson, Chemist and Assayer, in the following terms:—

"The pink mineral collected at the Q.E. Mine, Glenroebourne, is a cobaltiferous calcite, having the following composition:—

 Calcium carbonate
 ...
 97.55 per cent.

 Magnesium carbonate
 ...
 2.15
 ,,

 Cobalt carbonate
 ...
 0.71
 ,,

 Iron carbonate
 ...
 trace

 100.41

The mineral occurs in a large granular mass, with irregular boundaries. In small vughs in the mass rhombohedral crystals are developed.

I can only find two references to a similar mineral. Dana (Second Appendix) makes a note of a calcite containing cobalt from Traversella, Italy, described by Spezia (Atti Accad. Torina XLII., 1907.) No details of composition are given.

Leitmeier (Doelter's Handbuch der Mineralchemie), refers to a cobaltiferous calcite (for which the name Cobaltocalcite has been proposed) from Cape Colomita in Elba, described by Millosevich (Atti. Real. Accad. XIX., 1909). Its composition is given as:—

Lime					 54.41
Magnesia					 .27
Cobalt Oxid	e				 1.27
Manganese	Oxide				 trace
Iron Oxide					 .15
Carbon Dio	xide				 43.55
This is equal to	Calcii	ım ca	rbonat	e	 97.10
•	Coba	lt car	benate		 2.02

Other cobalt minerals already recorded from the Q.E. mine are Cobaltite (sulpharsenide of cobalt) and Erythrite (hydrated arsenate of cobalt.)"

Another interesting specimen from the Quod Est mine was a piece of lode containing metallic copper.

Yannery Hill Copper Mine.—At a distance of about 26 miles south of Roebourne what promises to be a large copper ore deposit, similar in many respects to the Whim Creek Copper Mine, has recently been found by Kelly and party.

On the surface the lode, or series of lodes, form ironstone outcrops, which when broken show the green copper carbonate occurring freely throughout. In all there appear to be about nine lodes running parallel to one another in a belt some 200 to 300 feet wide. The surface of the ground is so broken, however, that is is impossible to say at present whether these outcrops represent separate veins or the broken portions of one or two main cupriferous lodes.

A certain amount of costeening has been done, but to no great depth.

A shaft with a vertical depth of 32 feet has opened out one lode for that distance below the surface, the lode being in the sides of the shaft from top to bottom. This lode varies from seven to two feet in thickness and contains green carbonates, red oxides, etc., and in bulk when hand dressed will assay as high as 30 per cent. copper. The general strike of the ore channels is north 60 deg. west, with an underlie at a high angle to the north-east.

The enclosing rocks are undoubtedly altered sediments, probably of the Nullagine Series.

In close proximity to the Copper deposits and covering them on the north-west end are horizontally bedded sandstones which form the cappings here of most of the lowest hills. To the southeast, about one mile distant, several gabbro dykes, rendered conspicuous by their black outcrops, are seen intruding east and west through the sediments and sometimes forming the crests of the hills.

Leaving the "Yannery Hill" and traversing about one mile to the west of south on to the flat country, the Trouble Copper Mine is reached. The outcrop of the lode on this property consists of ironstone and can be traced for several hundred feet. From some shallow workings which have since been filled in by flood waters, some bunch copper ore had been mined and was lying at grass. The strike of the lode is north 50 deg. west, with an underlie of north 40 deg. east. For almost the full length of the lode traces of copper could be seen, but owing to the level nature of the ground, the size of the lode was obscured. Unfortunately, too, the scanty workings had been filled up by flood waters.

Both the Yannery Hill and Trouble Copper Mines are held under option of purchase by Messrs. Bewick, Moreing and Co., and there is a probability of a considerable amount of capital being expended in thoroughly exploiting both deposits, which, if successful, will doubtless give copper mining an impetus throughout the district.

Table showing the Total Production of Copper in the West Pilbara Goldfield to end of Year 1911.

Mining Centre.	Name and Number of Mine.	Copper. Ore.	Metallic value. Copper.		
		tons.	tons.	£	
Croydon	Croydon (M.L. 26)	40.00	8.60	945	
Do	Evelyn: British Exploration of Australasia, Ltd. (M.L. 31)	549.00	96.00	6,463	
Do	Quamby (M.L. 103)	15.00	$4 \cdot 05$	275	
Egina	Egina (M.L. 3)	530.00	$102 \cdot 95$	6,571	
Do	Egina (M.L. 91)	12.00	1.20	72	
Roebourne	Carlow Castle (M.L. 14)	133.00	$29 \cdot 85$	1,991	
Do	Carlow Castle (M.L. 15)	6.00	1.00	100	
Do	Carlow Castle: Roebourne Copper and Gold Mines of W.A., N.L. (M.L. 65)	81.00	19.88	1,415	
Do	Ena Extended (M.L.73)	6.50	.77	55	
. Do	Ena Reward (M.L. 118)	$20 \cdot 00$	$2 \cdot 87$	150	
Do	Federation (M.L. 42)	$26 \cdot 00$	$6 \cdot 24$	468	
Do	Fortune, M.L. 64	$51 \cdot 07^{-}$	11.68	690	
Do	Glenderry (M.L 49)	$22 \cdot 00$	$4 \cdot 40$	287	
Do	Lily Blanche (M.L. 77)	$997 \cdot 00$	$186 \cdot 99$	17,541	
Do	Quod Est, M.L. 150	$215 \cdot 56$	$26 \cdot 39$	1,514	
Do	Trouble, M.L. 138	$23 \cdot 21$	$6 \cdot 22$	343	
Do	Wait-a-while (M.L. 135)	$36 \cdot 05$	$9 \cdot 87$	601	
Do	(F. Smallpage), P.A. 100	37.00	$8 \cdot 43$	482	
Do	(MacDonald, J. J.), P.A. 108	7.40	1.26	72	
Whim Creek	(Balla Balla Copper Mines, Ltd.), M.L. (5, 12), 34	2,009 · 00	166 · 33	12,036	
Do	Balla Balla: Whim Well Copper Mines, Ltd., M.L. 34	21.00	2.80	154	
Do	Rushall's Lease (M.L. 10)	20.00	3.00	150	
Do	Stranger (M.L. 33)	10.00	$2 \cdot 50$	100	
Do	Whim Well Copper Mines Ltd. (Loc. 71)	37,021 · 03	5,605 · 24	338,340	
	Totals to 31st December, 1911	41,888 · 82	6,308 · 52	390,465	

N.B.—The numbers of leases which were not in force on the 31st December, 1911, are shown in parentheses.

ON THE TAILINGS LYING AT THE PORTAMINNA BATTERY, ROEBOURNE.

In accordance with instructions (M 636/12) I visited the Portaminna Battery to look into the question of the tailings lying there with regard to their tonnage, value, and payable extraction of gold by cyanide from same.

As far as I could ascertain, the following are the facts of the case :—

The battery, etc., was taken over by the present holders under an agreement that the purchase of the same was to be made by payments in periodical instalments. Up to date these instalments have been forthcoming in accordance with agreement. the agreement there is no mention of tailings, but the present owners state that it was understood the tailings lying on the ground when the inventory of plant, etc., was taken went with the lease. Acting on this idea, they, the present owners, have since covered over the original tailings with the sands from the subsequent crushings-160 tons for the public and 960 tons from the mine. (Their books show this amount crushed since the date of signing the agreement). This would mean that they have probably accumulated 900 tons of sands since signing the agreement. At present there are probably 1,100 to 1,200 tons of sand in the dumps. A considerable tonnage of the dumps has been washed away by flood waters, how much is not ascertainable, though the owners assert that it was mostly from the original heap? Under the circumstances, it was impossible for anyone to sample and estimate the tonnage of the original heap of tailings. On looking through the Company's books which were laid open to my inspection, I found that the original tailings had been sampled and tested by one C. C. Nardin, and I think the Department would be perfectly safe in taking his figures as correct, as he is generally known as a competent assayer and cyanide expert. His figures show that the tailings as they were taken from the settling pits were worth about 6dwts. per ton as against 5dwts. 7grs. (av.) from the samples taken by the Mining Registrar at Roebourne. In experimental treatment, Mr. Nardin reduced the tailings to a value of 1dwt. 5grs. with a consumption of 1lb. of evanide per ton, i.e., an extraction of 4dwts. 19grs. per ton. As the consumption of cyanide is very high the extraction would probably be lower than this in actual practice. say about 17s. per ton, taking the Department's assays into con-Allowing for the large capital outlay involved for a plant to treat such a small heap the initial cost per ton would be very high, at the very least 12s. to 13s. per ton, though, of course, the plant would be available for further use. A plant was in course of construction in June, 1912.

Taking everything into consideration, the vagueness of the agreement, uncertainty as to what sand belongs to the original

lease, and what to the present holders, the smallness of the heap in dispute, etc., it appears to me that it would be wise to drop the whole matter and grant a license free from any royalty.

After leaving Roebourne, I first endeavoured to reach the end of Flying Foam Island on the west side of Nicol Bay.

This portion of the coast forms an island at high tides, but in neap tides is connected with the mainland.

I was told on good authority that there were some lead and silver lodes on the end adjacent to Dolphin Island, so resolved to try and get across by land. We certainly got across on foot, but could not find water, and after nearly losing a horse or two, gave up the attempt.

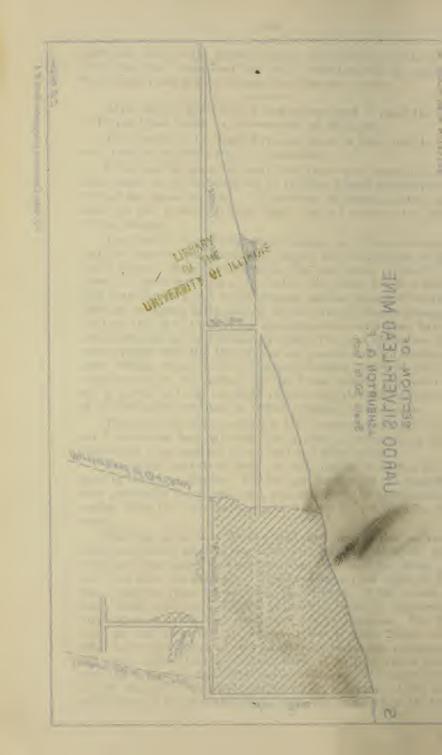
The locality proved interesting, however, as it was ascertained that the country rock consists of gabbro and not granite as one would expect. Reliable information has also come to hand that there is a small lead lode at the end of the island, but it is below high-water mark, a fact which presents serious mining difficulties. There is no mining being carried on, nor even legitimate prospecting from this ou to Onslow, any prospectors who were there having been forced out by the prolonged drought. The want of rain was not very apparent until Red Hill Station was passed, and then conditions grew steadily worse until it became impossible to travel without carrying fodder. On account of this I was able to stay but one day at Uaroo, and that was made possible only through the courtesy of Mr. McCarthy, who lent us sufficient fodder for the horses.

There were no mines working at Uaroo centre when I was there, but I have since been informed that a party of miners have been despatched to re-open the Uaroo lead and silver mine.

This mine is situated about one mile distant from the homestead of the Uaroo Station. For the past three years the mine has been practically abandoned, as a comparison of the accompanying section, Plate IX., with that shown in *Bulletin* No. 33, page 72, will reveal.

The lode, which is a silicious lead-silver one, strikes approximately north and south through the total length of M.L. 43. Unfortunately the upper workings are stoped out and had fallen in but No. 3 level was accessible. This level has a total depth of 346 feet. Starting from the entrance, the direction of the tunnel is south 55deg, west for a distance of 150 feet, when it intersects a copper-stained quartz reef some four feet in thickness. For the next 90 feet the strike of the quartz lode is south 20deg, west, when a well-defined lens of lead sulphide ore makes its appearance. The length of this lens of ore is upwards of 90 feet, with a maximum thickness of six feet. The lead ore disappears at a point about 15 feet from the south end of the drive. At a distance of 300 feet south from the mouth of the drive a winze has been sunk on the lode

H.J. Pether. Government Lithographer, Perth. W.A.



a vertical depth of 50 feet, and drives 15 feet south and 10 feet north have been made from the bottom of the winze. In the face of the north drive the ore shows a width of six feet with only a small percentage of quartz, but in the face of the south drive the lode contains only traces of lead sulphide. From top to bottom of the winze a fine body of lead sulphide is visible in both sides, the width of the solid lead sulphide probably averaging about 2 feet 6 inches. It is proposed to sink a new shaft to the east of the outcrop and at such a distance that the ore channel will be intersected at a vertical depth of 200 feet. This will enable the ore exposed below the No. 3 tunnel to be advantageously worked as well as thoroughly ventilating the mine workings—a very necessary precaution during the summer months. Moreover, thorough ventilation should be insisted upon to prevent lead poisoning of the miners, which heretofore has been far too prevalent.

The geological features of the Uaroo district have been thoroughly investigated and reported on in full by the Government Geologist in *Bulletin* 33, and need no repetition.

The following returns of the Uaroo centre have been compiled from official records:—

Uaroo Centre, M.Ls. 43 and 49. 1908—tons, 727.25 Lead—tons, 531.85 £6.914 1909—tons, 440.00 Lead—tons, 270.77 £3.520

Total—1,167.25 802.62 £10,434

METHODS FOR ADVANCING THE MINING INDUSTRY.

The question: "The best methods to adopt to advance the mining industry of the North-West"? presents many difficulties. Most of the disadvantages have already been pointed out by previous writers on the subject: the following I consider to be the principal ones:—

(1.) The isolation and scattered nature of the deposits themselves. (2.) Scarcity of timber for mining purposes. (3.) The severe climate. (4.) The more or less irregular water supply. (5.) The high cost of living. (6.) The heavy freights and transport charges. (7.) Inadequate ore crushing and reduction plants. (8.) Lack of capital for development. (9.) Insufficient prospectors.

Of these, the first three are unavoidable and must be overcome by reducing costs in other directions. As regards the water supply, a good deal has already been accomplished, and in most centres there is at present an adequate supply of water for drinking purposes. Freights and transport charges have been reduced, and doubtless a lower cost of living will follow for some centres such as Lalla Rookh, North Pole, Marble Bar, and the outlying districts,

Bamboo Creek, Nullagine, etc., by the Marble Bar-Port Hedland Railway, and there seems little chance of doing more in this direction for the present. It is unfortunate that the present railway does not serve more mining centres.

Dealing with the question of crushing facilities and ore reduction, the subject must be divided into two: (a) that for the baser metals, (b) the recovery of gold.

- (a.) As regards the copper industry one of the greatest disadvantages to the prospector is the prolonged wait for returns. Not including the costs of mining and living, the outlay for each ton of ore shipped varies from £7 to £11 per ton, the greatest part of this outlay is used up in transport to the port, wharfage, freight, etc.; added to this is a prolonged wait of anything up to say, six months, for a return from the smelters. This not only discourages men from seeking for copper ore, but also hampers them so much that they have often to cease operations. To obviate this I would suggest that the State receive the ore at Fremantle and advance an amount which would cover all subsequent charges, leaving a margin sufficient to guard itself against loss. This would be an inexpensive undertaking, and certainly a great help to the average prospector. The same might be done with the tin oxide, though at present a fair price is paid by the storekeepers who are at present acting as buyers on the spot. There was not sufficient copper ore in any of the centres I visited to warrant the erection of a concentrating plant or smelter. As regards tantalite, scheelite, stibnite, asbestos, etc., help could be given the producer in placing these minerals on the best market, for at present it seems that they are unable to sell their outputs, owing to the fact, they affirm, that they cannot realise anything approaching the quotes that they see published. I cannot vouch for the accuracy of this statement, but consider that it is most likely correct. If an arrangement could be made with some reliable agent in London, or elsewhere, whereby the product could be sold ahead, say, f.o.b. at a W.A. port, preferably Fremantle, and a small advance made on the parcel, I feel sure that there would be considerable quantities of the baser minerals of this class immediately forthcoming.
- (b.) The recovery of gold from stone which has been mined or developed is open to serious consideration. At present the only crushing plants in the whole district are five or 10 head batteries at Marble Bar, 20-Mile Sandy (Government mills), Eastern Creek, Barton G.M., and Warrawoona, and a tin dressing plant at Mt. Cassiterite (Wodgina). It is useless to expect prospectors to exploit anything but high-grade ore in any centres away from a crushing plant, and it is equally absurd to erect a mill at any centre unless there is a reasonable prospect of sufficient ore being found to keep that mill working.

To encourage prospecting, which is essentially the backbone of any mining industry, especially in a sparsely populated district like the "North-West," I would make the following suggestions:—

- (a.) That in all centres an adequate and permanent supply of water be sought for at least for domestic uses. This I consider to be absolutely essential.
- (b.) That a crushing plant be promised for any centre which can show sufficient payable ore to keep a mill employed.

That the mining industry can be advanced by the judicious granting of money for development has been often proved, and in the North-West it should have a marked effect if properly carried out. Personally I would favour it more particularly for:—

- (a.) Advances on machinery to enable prospecting at greater depth.
- (b.) Subsidies for developing low-grade propositions such as the Nullagine conglomerates.
- (c.) Transport of trial crushings and reduced charges for crushing same.
- (d.) Advances on special occasions for boring, either for water, ore channels, ore deposits, etc.

I feel confident that if the prospectors be encouraged by the carrying out of some of the above suggestions, more particularly the provision of permanent water and means to realise on what may be discovered, that prospectors will soon be found to open out fresh mining centres as well as resuscitating some of those at present abandoned.

In conclusion, I take this opportunity of thanking personally the following:—

- J. Sanderson, of Bamboo Creek.
- M. Doherty, of Eastern Creek.
- W. Hutchinson, Manager of the Cassiterite Mine.
- H. McGuiness, Wodgina.
- W. Breen, North Pole.
- L. Cook, Soanesville.
- F. Smallpage, Roebourne.

And many others who did much to help me in my work; also the Government officials throughout, and the owners and managers of the various stations on whose generosity we were at times absolutely dependent, and to Alf. Royer, who piloted me successfully over many roads and rough places, and whom I can heartily recommend as a most competent guide and horseman to anyone doing a similar trip on the Pilbara Goldfields.

APPENDIX.

The Pilbara and West Pilbara Goldfields.

(By E. Davenport Cleland).

The time occupied in making the inspection of the various districts, during August and September, counting from the date of arrival at Port Hedland to day of departure at Cossack, was eight weeks four days. The distance covered in coach and buggy, from start to finish, was approximately 850 miles.

The districts were visited in the following order:—

Lallarookh, Marble Bar, Just-in-Time, Marsh's Asbestos Claims, Warrawoona, Nullagine, Middle Creek, 20-Mile Sandy, Mosquito Group, Eastern Creek, McCarthy's Claim (west of Wyman's Well), Moolyella, Bamboo Creek, Talga-Talga, Cooglegong, Pilbara Asbestos Co.'s Leases, ("Chrysotile!"), McPhee's Claims (20 to 25 miles south of Lallarookh), Wodgina, Siffleete's Claim (south of the Stannum Group), Pilbara, Station Peak, Whim Creek, Roebourne, Weerianna.

Throughout these districts very little mining was in progress, and only in a few instances did I meet with any serious efforts to open up the reefs at depth.

The majority of the leases were in the hands of prospectors and fossickers following small leaders of quartz and working alluvial by dry-blowing.

The reason usually given for not working the reefs was the want of facilities for crushing ore, or, where a battery was in the district, the high rates charged for crushing, and the cost of cartage.

There was, undoubtedly, some truth in this, but it was also commonly apparent that the majority of the workers were not skilled miners. There were, of course, a few exceptions to this rule, and more of like nature will be required if mining in the North-West is to progress as it should. What are wanted are

skilled men possessed of a little capital and able to combine to creet small ore-treatment plants. When such combinations are possible, and the co-operators are short of funds to purchase the necessary plant, the assistance of the State in this respect would be of general benefit.

The cost of fuel, stores, wages, and living conditions generally were the same as those quoted in the report of the State Mining Engineer on these fields in April-May, 1907.

But, in the face of high prices, it was curious to find that good board at the hotels was usually not more than 25s. per week—very little, if at all, higher than the tariff on the Eastern Goldfields. Men who "did for" themselves assured me they could live as well as they required at a cost not exceeding 20s. per week.

Fuel for steam purposes is, practically, non-existent, and the same remark applies to timber for mining; supplies are very small in view of any extensive work going on, and the cost is very high. At Warrawoona, the Klondyke Boulder Co. made a contract for a supply of 100 cords of firewood at 25s. per ton, but on completion of this they could not obtain further supplies under 35s. per ton. The high charges are based on the fact that the natural feed does not suffice for horses when working; that some artificial feed is necessary, and that fodder costs about 28s. per bale of 100lbs. weight. It is said that there is a good supply of mulga firewood some 40 to 50 miles south and east of Nullagine, but this would mean the construction of a railway line to make it available. The smallest possible quantity of timber has been used to secure the mine workings throughout the fields. Such as it is, the creeks and river beds are the sole source of supply and not by any means an unlimited one. It would be advisable to protect this timber to some extent by creating the river beds forest reserves and permit cutting and carting only under license. This would be some protection against the total denudation of the rivers, and would also be a check on waste. For battery and all power purposes it will be cheapest to instal oil and producer-gas engines at the outset. Two or three small oil-engines are in use in the Marble Bar district for electric lighting, pumping, etc. At the Mt. Cassiterite mine, at Wodgina, a 60 to 70-h.p. oil-engine is in use. On this plant the consumption of oil is given as 2 gallons per hour at 1s. per gallon, or a total cost of 16s, per eight hours with a full load on the engine. For hoisting in shafts, oil or gas engines could be used in conjunction with friction hoists.

The cost of transport from Port Hedland has been a serious item of expense. As a result of inquiries regarding the estimated difference the railway would make in this respect, Mr. G. W. Miles, of Marble Bar, kindly furnished me with the following comparative table. The present landed costs are placed in one column, and in

the other the landed costs on completion of the railway to Marble Bar, allowing freight to be £2 per ton from Port Hedland, which works out a shade over fourpence per ton per mile:—

	It	em.			Present Cost.	Future Cost.
					Per ton.	Per ton.
					£ s. d.	£ s. d.
Sugar					33 0 0	27 0 0
Flour					22 0 0	16 0 0
Salt					13 0 0	7 0 0
Fodder					17 0 0	11 0 0
Galvanised	Iron				34 0 0	26 0 0
Bar Iron					25 0 0	17 0 0
2002	• •				Bushel.	Bushel.
Lime					0 5 7	0 3 6
Dillio	• •	• •	• •		Cask.	Cask.
Cement					3 4 0	1 16 0
Comono	••	••	• •	• • •	Load.	Load.
Jarrah					22 10 0	14 10 0
o arran		• •	• •	• •	Case.	Case.
Explosives					3 0 0	2 15 0
					172 19 7	123 4 6
					Minus 28·5 per cent. off to future.	Plus 39·8 per cent. on to present.

PILBARA GOLDFIELD.

MARBLE BAR DISTRICT.

Lallarookh Centre.

No work is going on here, and there will probably be no revival until about the time when the railway is completed as far as the Gorge River Hotel.

On the British Exploration Co.'s leases the mine and plant are idle, and the information I was able to glean was afforded by men who had worked in the mine, and from consulting the plans which were placed at my disposal.

On the Reward Claim the shaft on the north reef has a total depth of 150ft., and a level has been opened at 141ft. This has been driven easterly 91ft. and westerly 40ft., the former connecting with an old underlay shaft and the latter with a winze from No. 1 level. At No. 2, or lowest, level the reef is stated to vary in width from 18 inches to 9 feet, and to be lens-shaped. The quartz gave pros-

pects of free gold as high as 2.50 ozs. per ton. A good deal of sulphide ore was met with and yielded assays as high as 11 ozs. per ton. From No. 1 level to surface the reef has been stoped out, but, judging by the plans, ore remains between the two levels, and is also under foot. On the south reef a fair amount of development work appears to have been done, but judging by statements made the values were not as good as in the north reef.

The poppet legs at the main shaft on the Reward Claim are of light timber, poorly constructed, and not capable either in height or strength for economical work. The upper section of the shaft is small, but below No. 1 level it has been carried down on larger dimensions; but both gear and shaft are sufficiently good to enable the reef to be proved to a greater depth—work that should certainly be undertaken. The battery originally here has long since been removed. A winding engine in good order and a tubular boiler are at the main shaft, and there is a good outfit of tools and stores.

The Lallarookh belt of country consists of greenstone schists standing vertically, or almost so, and all along the western side of the Main Range, both in a northerly and southerly direction, there appear to be good indications for reefs and lodes.

The official returns show that up to date this centre has yielded 7,717.51 ozs. of gold from 6,532.50 tons of ore, an average of 1.18 oz. per ton.

Marble Bar Centre.

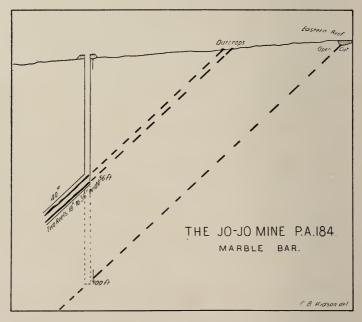
The Black Angel P.A. 198, owned by H. Newman and party, 18 acres, lies about four miles northerly of the town of Marble Bar. This claim adjoins the eastern boundary of an old claim known as the White Angel, long since abandoned as unpayable under the then conditions. As a rule the reefs in this district strike about N.E-S.W., but the one being worked on the White Angel strikes a little south of east and dips north about 45deg. It has been prospected along the surface for about 300 feet in length, and several holes and shallow shafts have been sunk. At the time of inspection the principal shaft had been sunk 30ft. on a reef about 12 inches wide. The quartz is a good deal ironstained, and also shows some iron pyrites. A crushing of 10 tons yielded 8.80 ozs. gold by amalgamation. The value of the gold is stated to be £3 17s. 6d. per oz. by test made at the Bank.

The eartage from the claim to the Stray Shot battery (a little over four miles) was 20s. per ton, crushing 30s. per ton, making a total of 50s. per ton exclusive of the cost of mining. On one of the other reefs observed the strike was north-east and the width-of-

outerop 18 to 36 inches. From this, pan prospects are stated to have yielded up to 1 oz. per ton. The country rock is a soft, easily worked schist, which stands well without timbering.

The New Chum Railway, G.M.L., No. 672 (12 acres), owned by Maher & Devan, lies about three miles north of Marble Bar, and a little to the east of the main road and railway survey. The outcrops of a series of lenses of quartz can be traced for 400 to 500 feet along the surface, striking approximately north-east and dipping about 40deg. north-west. The quartz shows iron oxide and pyrites and a little carbonate of copper. At the western end of the line a shaft has been sunk to about 15ft. on the underlay, showing 9ft. wide of quartz on the eastern end. From this shaft a parcel of 45.22 tons of ore was crushed for a yield of .59 oz. per ton. A stone picked from the outcrop by me showed fairly coarse free gold. The old shaft is wrongly placed at the extreme western end of a lense. The owners propose to resume work shortly.

Fig. 30.



The Jo-Jo, P.A. No. 184 (10 acres), held by Hammil and Thomas, is situated about a mile and a half north-east of Marble Bar and to the north of the old General Lease (Fig. 30). The reefs on this property lie to the west of, and parallel to, the Ironclad line of reef. They strike north-east and dip north-west about 40degs. The outcrops of three reefs are visible, the most easterly one being

along the crest of a low hill. The eastern reef has been slightly worked by open-cut on the outcrop at several points along its course. The quartz obtained in this way is stated to have been crushed for an average yield of .70 oz. per ton. Some 600 or more tons are lying broken on surface, and estimated by owners to be worth .60 oz. per ton, and not payable under existing conditions.

At about 118ft, west of the eastern reef the remaining two reefs have been intersected at a depth of about 54ft. by a small vertical shaft. In width they vary—in lens shape—from an inch or so up to 18 and 36 inches. From the bottom of the vertical shaft the reefs have been followed 26ft., and at the bottom they appear to be inclining at a higher angle. A band of soft greenstone schist, 24in. thick, separates the two reefs but does not carry any value. At a point a little below the bottom of the vertical shaft a level has been driven 60ft. on the reefs in a north-easterly direction, and their size is maintained in this length; the values have also been consistently kept up. At the point at which the shaft cut the reefs a parcel of 91/2 tons is said to have yielded a return of 22.75 ozs., or an average of 2.39 ozs. per ton. In July of this year the official returns show that a parcel of 49 tons vielded 153.07 ozs., or an average of 3.12 ozs. per ton. This was obtained from the drive above mentioned, and was crushed at the Stray Shot battery. Crushing cost 30s. and cartage 5s. or a total of 35s, per ton exclusive of owners' time in working at the battery and the cost of breaking and raising the ore.

The deepening of the shaft a further 40 to 50 feet should result in cutting the eastern reef. This development will be attempted when a new and larger shaft is sunk—work that the owners purpose doing shortly when they have some money in hand.

Adjoining the Jo-Jo on the south the old Bohemian is being worked by two men who are now sinking a shaft to cut the same line of reef as that in Hammil and Thomas's claim.

North of the old Band of Hope mine and, apparently, on the same line of reef, a prospecting area of 18 acres has recently been pegged out by Godley and O'Neil.

In past years a number of shafts were sunk to prospect a series of small reefs but development was not carried out to any extent. On sampling the quartz dumps at these shafts the present owners estimated the value to average loz. per ton and have now set to work to further test the country.

The Ironclad Line of Reef is not now being worked, and the shafts, etc., were inaccessible to inspection. From what could be seen from the surface a good deal of stone is in sight. It is certain

that this line of reef will be again worked now that a State battery is to be erected. The yield per ton for an output of over 2,000 tons is recorded as averaging .70 ozs.

The Railway Signal G.M.L., No. 658, 24 acres, is held by Browning and Maher. This area includes the greater portion of what was known as the General Lease.

A good deal of work has been done on this mine in past times. No underground inspection was possible owing to the workings having caved in in some places and, in others, being full of *débris* and waste rock left by fossickers.

It is intended to resume work here. The owners will probably save both time and expense by opening fresh shafts, etc., rather than trying to re-enter the old workings. At one point—near the summit of a hill—a tunnel exposes four reefs lying one behind the other. A selected parcel of 30.36 tons from this place averaged ·96oz. per ton.

Passing southward from the Railway Signal lease towards the Homeward Bound, a number of reefs are outcropping through the schist, and very little prospecting has been done upon them.

On the *Homeward Bound Mine* an old shaft is being cleaned out and prospecting is being again undertaken. Prior to my departure further sinking had disclosed a new reef of 5ft. in thickness and carrying gold. I had previously pointed out to the owners that the reefs occurred one above the other, and that sinking should be continued through the schist and until the granite footwall was reached. A good deal of shallow prospecting work was done on this lease years ago, and the reefs exposed in the workings show thicknesses of from 24 to 36 inches. It is stated that from these workings 455.50 tons of ore yielded 526.30 ozs. gold, or an average of 1.15 oz. per ton.

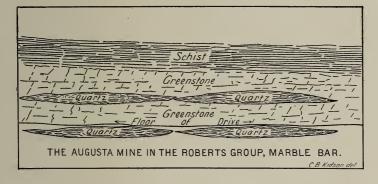
Adjacent to the Homeward Bound are the Shamrock, the True Blue, and the Coongan Star mines. None of these have been worked for some years past, and the workings were inaccessible.

Southerly from the Homeward Bound mine is the Roberts Group, comprising the Stray Shot, the Excelsior, and the Augusta mines, aggregating 24 acres. A portion of this ground was at one time known as the Coongan Gold Blocks Consolidated. In the group the Excelsior lease is in the south-west corner, with the Stray Shot to the northward, and the Augusta situated on a hill and lying along the eastern boundary of the two other leases. The leases are riddled by a number of small vertical shafts sunk to intersect

a flat-lying reef which outcrops along the summit of the hill to the east. From each shaft the reef has been mined as far outward as the nature of the ground permitted safe working. It is stated that the aggregate quantity crushed from these workings was about 5,000 tons, and the average yield slightly over 2 ozs. per ton. The 10-head battery on the Stray Shot lease is about worn out, and the boiler unsafe to use.

In this group I was able to inspect a portion of the underground workings of the Augusta Mine. The reef outcrops fairly boldly on the eastern slope and near the crest of a low hill (Fig. 31). The thickness of the quartz is up to 36 inches at most, and occurs in lens-shaped bodies which succeed one another closely along the strike of the lode. The dip is westward at an angle of from 20 to 25 degrees, and at places almost horizontal. The strike of the reef is north-west and south-west. The hanging wall is solid greenstone,

Fig. 31.



above which is a soft schist which continues to the surface. The country is very strong and secure, and the larger excavations have been filled with rock and supported by stone pillars built up.

The workings expose two series of lenses of quartz lying parallel to one another, and separated by about 3ft. of rock, the lower lenses forming the floor of the workings. The lower series is said to have yielded as good prospects in gold as the upper one, and it is curious that both were not mined at the one time and so obtaining double the quantity of ore at no additional cost of development. A considerable amount of driving has been done, but the workings

are well secured and in good order, and mining could be resumed without expense in fixing things up. A good deal of quartz has been left standing, being, presumably, not of a payable grade at the time the mine was being worked. The exploitation of the reef now under foot, and the deepening of one or more of the vertical shafts in search of other underlying reefs—the existence of which is very probable—is work that would be worth undertaking.

At a point about four miles from Marble Bar, at what is known as the Big Schist, the Devan Reward lease (24 acres) is situated on the eastern side of Duffer's Creek. This area has been applied for by Daniel Devan. Several outcroppings of quartz mark the position of reefs on the top of a bold hill sloping towards the creek. The reefs strike a little west of north and dip at a low angle to the westward. At the time of my visit only a little prospecting work had been done at a few points along the outcrop of the strongest reef. I noticed coarse free gold in several stones in the heaps of quartz that has been broken out. As far as appearances go, the outlook for the owner is fairly good. In this locality the schist stands up very boldly, and, owing to its very dark and weathered appearance, forms a notable feature of the landscape.

At about three miles southerly from Marble Bar and one and a half miles westerly of the Big Schist Well is the Franklin Gold Mine, comprising G.M.Ls. Nos. 641 and 647, with an aggregate area of 12 acres. The reef outcrop is well defined and can be traced in an approximately north and south direction for upwards of a mile. The dip, near the surface, is about west 50degs., but appears to take a higher angle as it makes down. As no work was in progress, and there was no means at hand. I was not able to get to the lowest levels. A shaft sunk to a depth of 110ft, on the underlay has proved the reef for an average width of 48ins. In the upper workings there is a large quantity of stone in sight, said to be of payable value if it could be treated on the mine. From the bottom of the shaft a crushing yielded 11dwts, per ton, and as the cost of carting and crushing was high the owners became discouraged and stopped working. No work has been done for the past two years. It is a pity to see this mine lying idle. The outcrop is the longest and most regular of any in the district, and is contained in good "kindly" country. The elevated resition of the mine would enable the ore to be handled very economically if a battery was on the ground, and there is said to be no difficulty about water.

At about one mile south-west from the Big Schist Well is the Devan Lease, G.M.L. No. 687, held by Mitchie, O'Larey, Carboy, and Christy. It is at the foot of a range of high hills, and the reef outcrops along the crest of a low rise in the schist country. In a gully leading down from the present workings the remains of

old alluvial diggings can be seen. These are reported to have yielded very good results, but there is no record of the actual output of gold therefrom. The owners, at the present time, are sinking on the underlay of some rich leaders and lode material forming a casing on the hanging wall of a solid quartz reef. Near the surface a parcel of 5½ tons was crushed for a return of 16.84 ozs. gold exclusive of 30 ozs. obtained by dollying the richer specimens. Adjoining the casing is a formation composed of fine-grained schist carrying minute veins of quartz and ironstone. The owners informed me that for a width of 6ft, this is worth an ounce to the ton on the then face. The values, however, are not constant, but rise and fall very considerably. Eastward from the present workings is a large solid quartz reef said to yield prospects up to 15 dwts, per ton, but not considered sufficiently rich under existing conditions. Bismuth occurs in the quartz, and usually is accompanied with coarse free gold.

Northward along this line of country many reefs have been prospected and slightly worked for rich patches, but none of them is now being mined.

McCarthy's Reward Claim.—This is situated in Fielding's Gully, about four miles west of Wyman's Well. A Reward Claim of eight acres has been granted and an additional 12-acre lease has been applied for. The workings are on the eastern slope of a hill in which the schist is overlaid by a bed of conglomerate. Traces of gold in the schist below the conglomerate led to sinking an incline shaft to a depth of about 30ft., dipping west about 35deg. This intersected a seam of soft lode material lying between the conglomerate and the schist and having a dip to the east; this seam is rather more than a foot thick and carries some free gold. Very little work has yet been done at this point. No gold is found in the conglomerate. The total gold recorded up to end of July was 9.16 ozs. To the south of the incline shaft a vertical shaft is being sunk in a conglomerate formation. It is a large square shaft and, to me, it did not appear to be placed in a position to meet the goldbearing seam.

The Just-in-Time Workings are situated between nine and ten miles south-west from Marble Bar, following the old coach track. The road is very much washed out, and is not used, the present main road to Cooglegong being further to the north. I found that no work had been done here for a long time past, and no change had been effected subsequent to the visit of the Government Geologist.

The following table shows the total gold production in the Marble Bar Mining Centre up to the end of July, 1909:—

MARBLE BAR MINING CENTRE.

1909.
Ţ,
July,
318t
to
produced
Gold
Total

	Registered Name of Com-	Total Gol	Total Gold produced to 31st December, 1908.	31st Decemb	er, 1908.	Gold produce	Gold produced for seven months to 31st July, 1909.	onths to 31st	July, 1909.
No .of Lease.	pany or Lease.	Alluvial.	Dollied and Specimens.	Ore Treated.	Gold therefrom.	Alluvial.	Dollied and Specimens.	Ore Treated.	Gold therefrom.
G.M.L. 673 G.M.L. 641 G.M.L. 661 G.M.L. 652 G.M.L. 658 G.M.L. 615 G.M.L. 615 G.M.L. 68 P.A. 190 P.A. 190	Enterprise Franklin N. Extended New Chun Railway Railway Signal Thistle Phor. Aust.) Voided Leases Sundry Chains Godler, A. J. Hamill & Thomas Frew Chon Street Sundry Chains Godler, A. J. Hamill & Thomas Frew Chains Frew C		fine ozs. 69.06 71.26 35.57	tons (2,240lbs. 441-16 403-84 13-25 30-26 30-26 27-71 12,213-15 1,260-89	fine ozs. 23.97 430.10 430.10 29.27 29.27 420.68 17,292.55 1,772.50	fine ogs.	fine ozs.	tons. (2,240lbs.)	fine ozs. 21.14 21.14 16.84 15.07 8.80
	Banks	28 · 18	175.89	14,284 · 84	20,002.97	451.47	27 · 02	86.20	219.35

Total Gold production to 31st July, 1908.

479.65	202.91	:	20,222.32	20,904.88	1.40
:	•	:	:	١:	
:	:	:	:	:	poimens
:	:	:	:	:	and Sn
:	:	:	:	:	Dollind
:	:	:	:	:	lei.
Alluvial	Dollied and Specimens	Ore Treated, Tons of 2,240lbs.—14,371.04	Gold therefron, fine ozs 20,222.32	Grand Total, fine ozs	Average vield per ton of ore exclusive of Alluxial Dollied and Specimens

Warrawoona Centre.

The examination of this centre was commenced at the northwest end, and the mines are taken in the order of their occurrence.

The Bow Bells Mine.—G.M.L. 505, is not now working, and with the exception of a few shallow surface workings no inspection could be made. On an adjoining machinery area is erected a 10-head battery and other plant, all apparently in good order. A considerable heap of sands has accumulated from ore treated from this and other neighbouring mines, the gross value of which is stated to be 5dwts. per ton. Mr. Frank Atkins informed me he had cyanided 100 tons for an extraction of 4dwts. per ton.

The Gift Mine, G.M.L. 595, lies on the south-west side of the large quartzite dyke and had been worked by Messrs. Richards and Bradley for three months at the time of my visit; the vein being followed was the well known Kopcke's leader. The lenses of ore were shown to be from three to four feet in length with a maximum width up to 18 inches. The first crushing taken out by the owners averaged 3ozs. per ton and the second barely one ounce. Owing to the small size of the reef, the hardness of the country, and the strong inflow of water, this return was not considered payable and the claim was being thrown up. Sinking had been carried some distance below water level with the aid of a pump worked by a small oil engine. The inflow amounted to three or four thousand gallons per day.

The Golden Gauntlet Mine, G.M.L. 506, was not working. The depth of the shaft was given as 50ft. on a reef ranging from 24 to 30 inches wide, carrying a chute of ore 10ft. in length. A crushing taken from the dump at the shaft is said to have averaged ·62oz. per ton.

On the Gauntlet Mine, G.M.L. 483, a good three-compartment shaft has been sunk to 140ft. on the hanging wall side of a large, but poor, reef. The plant of the mine consists of a winding engine, boiler, etc., and steel head gear over the shaft. The mine has recently been in the hands of tributers who have taken out the best

of the stone down to water level. The tributers disregarded the large reef and confined operations to a dark-blue coloured quartz reef occurring on the southern side of the large reef. This originally had a bold outcrop showing coarse free gold and, in years past, gave very rich returns; why it was not followed down subsequently I do not know, but the omission was of benefit to the later tribute workers. They found that the richest ore occurred in pipes dipping at a high angle. Near the surface, the first pipe worked had a length of 16ft., but on being followed this increased to 30ft, with a width of 24in. Work was stopped at water level as no pump was available, but the value of the ore at that depth showed no falling off. From the ore obtained by the tributers the first parcel of 39 tons yielded 101·40ozs, and the second, of 30 tons yielded 76ozs. With a long-term tribute and a good pump these workers would have been glad to continue operations.

The Klondyke Boulder, G.M.L. 604, is the most important mine in the Warrawoona centre and has been worked for some years past. During the last two years it has been in the hands of Messrs. F. Atkins, Lynne, Cooke, and Cooper. Since they took possession a five-head battery has been erected, and the sinking of main shaft has been commenced. At the time of my visit the lowest workings were under water, and though I twice visited the district and pumping was being continued. I was not able to get below. workings were mostly caved in and did not invite inspection. water is being taken out by a steam pump at the rate of about 3,000 gallons per hour, and there is a considerable area of country to be drained before much effect is shown in the shaft. I am indebted to the manager for the following information. The shaft on the south reef has a depth of 190ft, and the reef has been mined to 185ft. The last 60ft. of sinking gave 400 tons of ore yielding 1,050ozs. of gold worth over £4 per ounce—a value said to be considerably higher than what was met with in the upper workings. The ore chute has been stoped for a length of 55ft. and appears to be lengthening as greater depth is reached. surface the width of stone was 12 inches and at 185ft. it is 27 inches. It is intended to deepen this shaft so as to get control of the water and keep the mine drained while the main shaft is being sunk.

The Main, or Blue, Reef is the more northerly of the two. At 50 feet from the surface it was broken by a fault, but was again picked up at a very little distance from the break. The workings on this reef comprise some of the oldest on the lease and have mostly caved in. The new main shaft has been placed in a position calculated to be convenient for the working of both reefs. It is 8ft, by 4ft, in the clear, and is now 56 feet deep. The country passed through is a rather soft schist requiring close timbering and the necessary sets have just recently come to hand. At a depth of 105ft, a crosscut

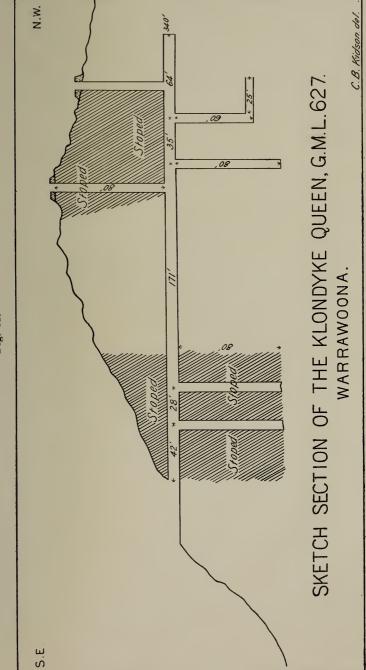


Fig. 32.

will be driven to test the existence of a low-grade ore body believed to exist on the southern side. The south reef should be met with at about 300ft. from the surface. The northerly or blue reef will anderlay away from the shaft. Since the erection of the battery the filling of some of the old stopes has been taken out and put through. From one parcel of 45 tons the yield was 25ozs. gold, and from another, 84 tons yielded 41ozs. gold. The battery and boiler is owned by a syndicate, some of the members of which are also shareholders in the Klondyke Boulder mine and in other claims round about. The mine pump is supplied with steam from a vertical boiler and there is also a small hoisting winch at the underlay shaft. The official record of gold won from this lease up to the end of July, 1909, is 959.79 tons for 1,824.65ozs. of fine gold, or an average of 1.90ozs. per ton.

The Klondyke Queen, G.M.L. 627, is owned by Royer and Atkins. The mine lies south-east from the Klondyke Boulder and is in the same run of country. The reef outcrops along the crest of a high ridge formed by a dyke of banded quartzite (Fig. 32).

In the past a fair amount of work has been done in sinking on pipes of rich ore. Concerning the value of these I obtained some knowledge through insight into one of the ledgers of the old owners of that mine. The bank account shows that from June, 1898, to March, 1902, 819 tons of ore were crushed for gold valued at £19,831, or an average of slightly over £24 per ton. This was a portion of the total yield, said to have been over £28,000.

The reef varies in size from a few inches up to 36 inches in width, and dips almost vertically, in conformity to the country. The larger portions of the reef really form pipes of ore which dip at a high angle north-westerly on the line of reef. The length of these pipes is from 6ft. to 12ft. Between these richer portions the quartz is of very low grade. The chief workings consist of a tunnel that has been driven on the course of the reef at a point about 20 to 30 feet above the bed of a creek which cuts through the easterly end of the lease. The tunnel is 340ft, in length and the reef is exposed for the whole distance. For about 70ft, in from the mouth of the tunnel stoping has been carried upwards to the surface and to a depth of about 80ft. below the level. A block of ground has also been stoped out above the level near its north-westerly end. Four winzes have been sunk, three to a depth of 80 feet and one to 60 feet. In the one last-named work was going on at the time of my visit, and a drive was following the reef off the bottom. At this point a pipe of ore had been picked up which had been lost in the upper workings; it was calculated to be worth 30dwts, per ton. On taking over the mine the present owners found that the filling of the stopes carried fair values. The filling has been withdrawn and crushed at the Klondyke Boulder battery. One parcel of 100 tons yielded 64.90ozs. gold, and a second of 87 tons yielded 67.10ozs, gold. Under its present title the records show a total to the end of 1908 of 75.75 tons, yielding $185 \cdot 20$ ozs, fine gold, and for the seven months ending 31st July, 1909, $276 \cdot 20$ tons yielding $215 \cdot 54$ ozs, fine, or a total of $351 \cdot 95$ tons for $400 \cdot 74$ ozs, fine.

Pursuing a south-easterly course the workings of the St. George, the Cuban, and the Britannia mines were passed, but no work was in progress.

The Reward Claim, now G.M.L. 682, is being worked by Messrs. Daly, Fredricks, and Verco, who took it up a few weeks ago. At the present time a shaft is 50ft, deep on Kopcke's leader, and the stone is showing a fair amount of free gold. At bottom of the shaft the vein is only about 6 inches wide but swells to 12 inches in places. A crushing of 18·50 tons yielded 26·67ozs, fine gold.

Adjoining the Reward Claim is the $Warrawoona\ Queen$, a P.A. held by J. Connor. This also is on the famous leader. A shaft has been sunk 32ft, and some good-looking stone has been raised. In these workings the vein and the country showed a lower angle of inclination at the bottom than in any other instance that had come under my notice.

At about a quarter of a mile from Connor's claim and at the foot of the range on the southern side is a freshly pegged P.A. named the Koombana. In this claim a fairly well defined outcrop of quartz can be traced for seven or eight hundred feet in length. Good prospects are said to have been obtained all along this line, but at present only a few pot-holes have been sunk at various points, the deepest being about 10ft. The reef strikes about 10deg, south of east, but the dip is not yet very well determined. The enclosing country is a soft schist, which at many points along the outcrop is seen to be very twisted. The long length of outcrop and the appearance of the quartz certainly should make it worth while for the owner to carefully inspect it. It has a very promising appearance.

I attach a statement showing the total production of gold from the Warrawoona Mining Centre as given in the official records.

It is noticeable that 36.94 per cent. of the ore treated and 28.97 per cent. of the gold therefrom was derived from two leases, the Bow Bells (505) and the Gauntlet (483), the last-named of the two having, apparently, made the highest yield per ton.

WARRAWOONA MINING CENTRE. Total Gold produced to 31st July, 1909.

	Registered Name of Com-	Total Go	Total Gold produced to 31st December, 1908.	o 31st Decemb	er, 1908.	Gold produ	Gold produced for seven months to 31st July, 1909	months to 31s	t July, 1909.
No .of Lease.	pany or Lease.	Alluvial.	Dollied and Specimens.	Ore Treated.	Gold therefrom.	Alluvial.	Dollied and Specimens.	Ore Treated.	Gold therefrom.
		fine ozs.	fine ozs.	tons.	fine ozs.	fine ozs.	fine ozs.	tons	fine ozs.
G.M.L. 505	Bow Bells (Brit. Explor.	:	:	483.70	753.59	:	:	(-5,0105.)	:
G.M.L.s 505, 483	British Exploration of Australes	:	. :	1,413.00	1,112.85	:	:	:	:
3.M.L. 675	Britannia	:	:	11.50	_	:	;	:	:
G.M.L. 483	Gauntlet	:	:	1,128.30	3,124.40	:	:	:	:
M.L. 465	Gaunder (Dileish Expt. Aust.)	:	:	13.00		:	:	:	:
G.M.L. 604	Klondyke Boulder	::	::	850.69		: :	::	109.10	57.39
G.M.L. 650	Klondyke Boulder East	:	8.33	14.00		:	:	• • •	1
G.M.L. 62/	Voided Leases	::	1.86	2.981 -11	8 306 82	:	:	276-20	215.54
	Sundry Claims	44.30	333 · 329	1,069.04		: :	: :	: :	
P.A. 175	Daley and Party	:	:	:	:	:	:	18.50	26.67
185	Andrews & Party	:	:	:	:	:	:	2.00	
.A. 186	Berteau, F.	:	:	:	:	:	:	00.8	
.A. 203	Fredericks, W		:	:	:	:	:	00-9	
		44.30	346.48	8,201.09	17,625.60	:	:	422.80	314.59

Total Gold Production to 31st July, 1909.

44.30	346.48	8,623.89	27,940.19	18,330.97
:	:	:	:	' :
:	:	:	:	:
:	:	:	:	:
:	:	:	:	:
:	:	:	:	:
:		:	:	ozs.
:	mens	, z,z+010s.) -8,623.89	nne ozs	Grand Total, fine ozs.
Alluvial	Dollied and Speci	Ore treated (tons	Gold therefrom,	

Average yield per ton of ore, exclusive of Alluvial, Dollied and Specimens .. 2.08 ozs.

Bamboo Creek Centre.

The Bulletin Mine (G.M.L. 161) has been worked by tributers for some time past. At the time of my visit only two men were at work at the 160ft. level. The whole mine, down to the deepest level -160ft.—has been very much rooted about by tributers, and the greater portion of the upper levels are so littered with waste rock that a thorough inspection was impossible. In those portions of the levels which could be seen some of the timbering was fairly good but much of it showed evidence of rot and was not very secure. The winzes, passes, and stopes were usually unprotected and will require to be attended to if and when work is resumed in the mine. vertical shaft connecting with the reef at 160ft, is not centred. Some of the sets are giving away and, generally, it is not fit for use until overhauled. On the surface the ravages of the white-ants are remarkable. Two sets of oregon poppet legs have been eaten through and the legs have broken short off at about half way up. The foundation logs under the battery boxes have also suffered in the same way. I am informed that an attempt is being made to get fresh capital in order to renovate the whole mine above and below ground. Judging by the past records of yields, by the present appearance of the reef at the lowest level, and the comparatively small amount of development work that has been done on the property. I should say that the expenditure of additional capital was fully justified and that in all probability a very good mine might be opened up.

The reef has been pretty well worked out from the surface down to the 160ft, level, but, as well as I could see at various points, no attempt has been made to seek for new lenses after the original one tapered out longitudinally. On the 160ft, level the reef is about 24 inches wide and the quartz showing free gold. The footwall is generally well defined but the hanging wall is not. From the reef many small veins and strings of quartz make outwards, and I am confident that the true hanging wall has not been touched. Crosscuts should be run out to test the full width of the ore channel; this, judging from surface indications, is fairly wide, and other bodies of ore will likely be found in it, lying parallel to the main reef. Some of the lenses of ore have been 5ft. in width. There is no reason to suppose that the reef will fail to make down, and further prospecting in this direction should be undertaken. Up to the end of July, 1909, this mine has given 4,066.50 tons of ore yielding 7,808.21ozs, of fine gold, or an average of 1.92 fine ozs. per ton.

No other lease in the vicinity is being worked, though from information I could glean from residents of long standing there are several mines that are well worth being further developed. The cause of stoppage is ascribed to the high cost of crushing charges in the past, and the great expense of getting mining stores to the district. Both these items should be much lightened when once the railway gets to Marble Bar, and the district may be expected to revive.

The Bobby Burns.—This is held by Messrs. Matheson, McKenzie, and Ball, and is situated about four miles west from the present Bamboo post office, in a locality known as Nuggety Gully. An incline shaft has been sunk 85ft. on a four-inch leader of quartz, which lies along the hanging wall of a diorite dyke. The value is very variable, and sometimes very rich pockets are found where the vein has passed slightly into the diorite. All the gold is obtained by dollying, and the owners say they are making good wages.

The following table shows the total gold production in this

86.75

49.14

82.00

(2,240lbs.)

fine ozs.

fine ozs.

fine ozs.

tons.

fine ozs.

ozs.

fine

Bamboo Consolidated G.M. Company, Ltd.

Bulletin ... Bulletin Leases Voided Leases Sundry Claims

653

G.M.L. 161 G.M.L. 161 G.M.L.s 161, Slags

P.A. 189 P.A. 189

centre up to 31st July, 1909:-

Gold produced for seven months to 31st July,

BAMBOO CREEK MINING CENTRE.

Total Gold produced to 31st July, 1909.

Total Gold produced to 31st December, 1908.

therefrom

Treated.

Dollied and Specimens.

Alluvial.

therefrom.

Treated.

Dollied and Specimens.

Alluvial.

Registered Name of Company or Lease.

No. of Lease.

Gold

. 4	: :	158.54 11,331.25 18,801.64	158.54 11,331.25 18,801.64	158.54
•	:	:	:	:
÷	:	:	:	:
•	:	154.40	144.00	158.54
	:	10,818.50	7,202.75	
٠	:	1,140.97	00.044	:
•	:	3,427.92	1,965.00	:
•	:	2,995.85	1,579.50	:

Total Gold produced to 31st July, 1909.

207.68	41.22	48.90	ozs.
;;	19 141.22	19,348 · 90	1.67
::	:		:
	:	:	ecimens
::	:		and Sp
Dollied and Specimens Ore treated, tons 2,240lbs.—11,418.00	old therefrom, tine ozs. (including slags)	Grand Total, fine ozs	Average yield per ton of ore, exclusive of Dollied and Specimens 1.67 ozs.

Talga-Talga Centre.

No reef mining is being done in this locality, but west of the alluvial workings on the western side of a high range of hills there are quartz outcroppings that are well worthy of attention.

In past years a prospector named McPhee worked one of these reefs to a slight extent, and is said to have found a very rich patch of stone therein. No further development appears to have been attempted.

The old alluvial claims are being fossicked by about 15 men, but none of them appear to be getting much gold.

The official record up to the end of 1908 shows the total output from this locality as follows:—

Alluvial			50.26 fine oz.
Dollied and specimens			152.82 fine oz.
Ore treated, tons (2,240lbs.) 7	79.15		
Gold therefrom	• •	• •	1,496.63 fine oz.
Grand total, fine oz			1,699.31
Average per ton of ore (excalluvial, dollied, and specim			1.92 fine oz.

It may be taken for granted that the total alluvial gold quoted above is not the actual output, and that a portion of the 7,888.14oz. reported by the banks and gold buyers in the Marble Bar district may be credited to this field.

McPhee's Claim.—On my way to Wodgina I turned off the direct track to inspect a place commonly known as McPhee's Claim. It is situated on the western side of the Main Range, and lies about seven miles north of Green's Well, 20 to 25 miles southerly from Lallarookh, and about the same distance east from Wodgina.

A fair amount of prospecting has been done on the surface, but the deepest working is not more than 30ft. No work was in progress at the time of my visit. From a prospector who had been working there recently I understand that gold had been obtained for a consecutive width of over one and a half chains and a length of 60 chains, the values ranging from traces up to eight and 10dwt. per ton. A good deal of dry-blowing has been done, and it is said that some very good patches were obtained. The country appears to be a hornblende schist in which bars of actinolite occur, and it is near these bars that the best prospects are obtained. Several small quartz reefs outcrop at surface, and one of these shows green carbonate of copper. Numerous small veins of quartz run through the schist also. The indications generally are those of a large lode formation, and the place deserves to be carefully prospected.

A Government well is within half a mile of the workings, but requires deepening to increase the supply. I am told that, prior to the discovery of the fresh water well, several bores were put

Table showing Total Ounces of Gold produced in each Mining Centre up to 31st July, 1909. PILBARA GOLDFIELD. MARBLE BAR DISTRICT.

down in the hornblende country and that salt water was struck; this would be valuable for ore treatment if the supply is found to be good.

Other centres.-I did not visit the North Pole, Tambourah, Western Shaw, etc., as I heard that only a few alluvial men were worki

le

Bar

	Total Gold	Total Gold produced to 31st December, 1908.	31st Decen	nber, 1908.	Gold prod	Gold produced for seven months ending 31st July, 1909.	n months e	nding 31st	ing, a I atta Distri
Mining Centre.	Alluvial.	Dollied and Specimens.	Ore Treated.	Gold therefrom.	Alluvial.	Dollied and Specimens.	Ore Treated.	Gold therefrom.	ich a t
	fine ozs.	fine ozs.	tons.	fine ozs.	fine ozs.	fine ozs.	tons	fine ozs.	at 1 able to
boo Creek		158.54	(2,240lbs.)	18.801.64		49.14	(2,240lbs. 86.75	339.58	e si
dalyerrie	::	148.85	120.25	587.86	: :	:	:	:	ho
en's Find	:	:	14.00	86.82	:	:	:	:	w
	:	:	135.00	316.31	:	:	:	:	in
ble Bar	81.88	175.89	6,532.50	20.002.97	451 - 47	27.02	86.20	219.35	ng ly,
th Pole	:		416.00	277.02	:	: : :	:	::	th
th Shaw	7.53	567.06	351-45	674.72	::	:	:	:	va 1e L9
rks	145.08		00.9	33.00	:	:	:	:	t
w River	:	:	101.00	49.63	:	:	:	:	of
ga Talga	50.26	152.82		1,496.23	:	:	:	:	n ta
upouran		64.65	2,077.75	2,536.88	:	:			p I
rrawoona stem Show	44.30	346.48	8,201.09	17,625.60	:	:	422-80	314.59	gc
man's Well	:	20.02	900.000	930-73	:	.0.16	10.00	19.61	og old
ndicoogina	:	373.36	9.768.95	5 718 33	:	OT . C	00.01	10.61	re l
District generally	: :	::	237.95	1.145.96	: :	: :	: :	: :	pr
Reported by Banks and Dealers	7,788-14	217.05	:	:	:	:	:	:	od
Totals	8,063.49		2,330.26 48,877.38	78,865.02	451-47	85.32	605 - 75	893.13	uce
	Total Go	Total Gold Production to 31st July, 1909	tion to 3	1st July	1909.				d i
Alluvial	:	:	:	:	:	Fine ozs. 8,514.96			n tł
Dollied and Specimens Ore treated tons (2.240lbs.)	ecimens	:	:	:	:	2,415.58			ie :
Gold therefrom	:	::	: :	: :	::	. 79,758-15			Ma
	Gross	Gross Total, fine ozs.	ozs.	;	:	90.688-69			rb
		,		:	:	an analan :			ol

Bamb Bood Breer Elsie Lalla Marb Nortl Sharl Sharl Sharl Warr Warr

Average yield per ton of Ore, exclusive of Alluvial, Dollied, and Specimens ..

TIN MINING.

Moolyella Centre.

About 50 men are at present engaged in re-working some of the old alluvial ground at Moolyella, and in dry-blowing the old heaps of tailings from the sluices.

In a few places work was in progress at depths of 20 feet or so. In those I inspected, the wash was being taken out for a thickness of about 18 inches; the best of it was estimated to yield from 4 to 6 ozs. per dish. As, in this district, about 80 dishes is called a load, the yield would range from 20 to 30 lbs. per cubic yard.

The present method of working the deepest ground is by sinking to the wash and then mining it by a series of chambers. These radiate from the shaft as far as payable results may be met with, and their width is governed by the strength of the ground, as estimated by the worker. Pillars are left standing here and there according to fancy and the value of the wash. The men say the ground seldom caves suddenly, but usually gives warning by commencing to fret and trickle. Falls are not of frequent occurrence, and accidents have been few. The ventilation of these workings, naturally, is poor, but as the men are working in their own time they can make frequent opportunities to breathe a purer atmosphere, and they show no signs of suffering from inhaling bad air.

The lodes showing on the granite hills are not being touched, as there are no means of treating the ore when mined. The erection of a small treatment plant would infuse fresh life in this district, and might result in some payable lodes being opened up.

The alluvial ground towards the north end of the field and in the vicinity of Brockman's Creek has been slightly tested by boring. But, apparently, the prospects obtained were not sufficiently good to induce the members of the boring syndicate to replenish its exhausted working capital. Further prospecting in this manner will probably be taken in hand now that the construction of the railway to Marble Bar is assured. The field is very conveniently placed to the proposed terminus of the line.

The total yield of tin from this centre to date is 2,628.59 tons, of the value of £224,355.

Cooglegong Centre.

In this centre about 80 men are at present at work. The number, however, fluctuates considerably. Only alluvial ground is being worked, and this is mostly represented by abandoned ground.

No lode mining is in progress, although small lodes are known to exist. The reason given is that there is no plant at which to treat the ore. In the absence of this no lode is touched unless it shows ore worth dollying, and this condition does not appear to be often met with. The present workers are not making more than wages—some less than that—and evidently do not possess means to combine to erect a small dressing plant.

The Cooglegong Creek is proved to contain tin, and at a point about 10 miles below Lloyd's store one man has been dry-blowing the sand bed. It is said that the average yield obtained by him is four ounces of black tin per dish. Recent rains flooded him out, and he was not working at the time of my visit. This creek should be worth prospecting with a view to working it in a large way. The simplest method would seem to be with a suction dredge working across the full width of the creek at various points. This would entail the expenditure of capital, and probably no person or syndicate would undertake the venture unless first assured of being able to secure and hold an extensive area of the creek bed. This centre is not likely to make much further progress until some means of dressing ore and dredging the bed of the creek is available.

The total yield of stream tin from this centre up to 31st August, 1909, is 1,236.29 tons, valued at £96,452.

Wodgina Centre.

The Mount Cassiterite Claims are owned by Messrs. Phippard Bros. At the present time a total of 22 men are employed. Owing to a want of water for the mill, operations on this mine have been greatly retarded. From the 3rd of February to 15th September, 1909, only 505 hours were run. In that period 1,987 tons of ore were treated for a yield of 59·60 tons of black tin.

At the time of my visit a new water shaft had been sunk 74½ feet. This is situated at about half to three-quarters of a mile west of the mill. At the depth named a supply considered fairly good has been struck, but the shaft is to be deepened in order to increase it. A 3-inch main has been laid from the mill to the well, and a pump was being installed while I was there. The motive power will be electricity supplied by the motor at the mill. The shaft has been well timbered, with frame sets lagged with corrugated iron. The cost to the owners of sinking and equipping the water shaft has been upwards of £1,000. On 1st June of this year an application for six months' exemption (5 men) was granted; this, however, has not been availed of, as it was found that the full number of required men could be profitably employed in connection with the water shaft and in mine development.

In regard to the water question, it will probably be found that the mine itself will ultimately provide large supplies of water. The winze from No. 2 level has been sunk 70ft.—a depth nearly equal to the level of the bed of the main watercourse which traverses the property, and further sinking was stopped owing to the presence of water. When this is deepened, or when the owners get a shaft down on one of the large lodes, the inflow of water will probably be found as large as will be required for all purposes.

Large quantities of water can also be conserved at no great cost by damming up one or more of the gullies on the lease, and impounding the storm waters caused by rain. Storage such as this could be profitably utilised for hydraulic sluicing the slopes of the hills and winning from the surface soil the tin contained therein. Pan tests appear to have proved that considerable quantities of tin lie in the loose dirt, and this scheme would almost certainly be profitable; in addition to tin actually won, the rock would be bared and prospecting for additional lodes be facilitated.

So far, the known tin lodes have been prospected by means of three tunnels driven at different levels from the side of the hill, the lowest of these being about 200ft. below the summit. A few winzes have been sunk, but on the whole no large amount of development work has been carried out. A little stoping has lately been commenced. All the workings are well secured and timbered.

The ore hitherto sent to the mill has been derived from the waste heaps left by the former owners, and there is yet a good quantity of this to be dealt with. The owners state that up to date the tin won from the mine represents a value of £20,000, and that this sum has been again spent in the development of the property. The mill was running on the day I left Wodgina, and I made an inspection of the plant. As a rule, all the working parts had been well protected, and only in one or two instances was it necessary to point out where extra guards would be required. The power for

the plant is derived from a Diesel oil engine of 65 h.p. With a full load, the consumption of oil is quoted at two gallons per hour, the cost equalling 16s. per eight hours run.

The ruling rates of wages are as follows:—
Hand miners, 13s. 4d.
Surface labourers and truckers, 11s. 8d.
Foreman blacksmith, 15s.

Boys, from 6s. 8d.

Telephone communication with Port Hedland is about to be established, and this will be of great convenience to the residents in the district.

The *Tinstone Lease*, adjoining the Mt. Cassiterite mine, is being worked by two men, and some other claims in the neighbourhood are also in work, but in each instance only the very best of the ore is taken, as owing to their being no dressing plant in the district the medium and low grade ore cannot be profitably dealt with.

About 10 miles direct south from Wodgina, and a little south-west of the Stannum Group, Siffleete's claim is being worked by the owner alone. Only surfacing is being done, and the best bunches of ore are bagged for export. There are several lodes exposed on this claim, and the surface indications are apparently very favourable. The claim is stated to have yielded 7 tons of black tin by dry-blowing and dollying.

No work is going on in the Stannum Group of leases, and further south the Mt. Francisco and other claims are simply being fossicked by a few men.

The prospects of the Wodgina centre appear to be very good, and if there was a dressing plant in the neighbourhood there is no doubt that the tin mining industry would quickly revive and a large export of tin result. Under present circumstances it is possible only to extract the very richest portions of the lodes for bagging, and this policy cannot long be continued. A central position for the erection of a plant would be in the neighbourhood of Siffleete's claim. This would serve the Wodgina, Stannum, and Mt. Francisco centres, and its erection would be a great boon to those places. The construction of the Port Hedland-Marble Bar railway will be of some assistance to these districts in reducing cost of transport to the sea-port, and the further south the line can be deflected the greater will be the advantage to these fields.

I attach the following table showing the total output of black tin in the Marble Bar district up to 31st August, 1909.

PILBARA GOLDFIELD. MARBLE BAR DISTRICT.

Table showing Quantity and Value of Black Tin produced up to 31st August, 1909.

igust, 1909.		Value.	£ #,778 7,401 4,865 220 	17,304
nths to 31st Au	Quantity.	Total.	tons. 59.95 95.51 69.50	228 · 21
Total produced for eight months to 31st August, 1909.	Quai	Stream.	tons. 59.95 95.51 	155 - 96
Total produc		Lode.	tons.	72.25
er 1908.		Value.	2, 91,974 91,974 195,614 195,614 14,525 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	345,907
Total Production up to 31st December 1908.	Quantity.	Total.	tons. 1,116-34 1,85 380-55 2,200-55 16-75 2-45 1159-87 1199-87 11-95 6-10	4,167.23
oduction up t	Quai	Stream.	tons. 1,176-34 330-53 2,202-55 6-73 211-04 13-85 6-10	3,995 · 51
Total Pı		Lode.	tons	171.72
	Registered Name of Company or Lease.		Sundry Claims Voided Leases Sundry Claims Voided Leases Sundry Claims Chamberlain Commonwealth Mt. Cassiterite Mt. Cassiterite Tinstone Voided Leases Sundry Claims	Total
	No. of Lease.			
	Locality.		Cooglegong Mill's Find Moolyella Do Old Shaw Old Character of Do	

Total Black Tin produced to 31st August, 1909.

Value.		£363,211
		£3
Tons.	4,151.47	4,395.44
:	:	: '
:	:	:
:	:	:
:	:	:
:	:	:
:	:	Total
:	:	
:	:	
Lode .	tream	
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COPPER MINING.

No copper mining is being carried on in the Pilbara Goldfield, but copper is known to exist in one or two localities.

The official records show that in 1907 a parcel of 7.77 tons of ore from the Roy Mine, M.L. 147, in the North Shaw centre, yielded 1.90 tons of metallic copper.

Warrawoona Centre.

At the south end of the main Warrawoona range of hills, near the old Ironclad battery, a vein of copper ore occurs in the schist lying along the northern side of the quartzite dyke. This has been traced for several miles in a south-westerly direction and in places has been slightly prospected. From what can be seen of it at surface the lode does not appear to have much width, but sufficient work has not been done to show whether it improves in depth. From some of the prospectors' workings samples are stated to have assayed 30 per cent. copper. The ore does not appear to have been tested for gold. It is probable, with the advent of the railway, that this lode will be further prospected.

Snell's Claims.—I heard of these while at Marble Bar but as, on making inquiry, I found that no work was in progress and no prospectors on the ground, I did not proceed thither. I obtained the following information from Mr. W. A. Snell who has raised and exported a small parcel of ore from the lode, and who states that he is about to apply for a lease. The ore was transported to Port Hedland by camel team returning from the Eastern Creek district. The locality is described as about 90 miles E.N.E. from Marble Bar by way of Bamboo Creek and Warrawagine Station. The lode is described as being 7ft, wide, and having an approximately north and south course. The ore occurs in bunches varying from 5 to 20 tons in quantity, and assaying 30 per cent. copper. Mr. Snell showed me account sales showing that in February, 1908, he shipped to H. A. Watson, of Liverpool, England, a parcel of 12 tons 18cwt. of ore, showing an assay value of 22.72 per cent. copper and 3.20 ozs, silver per ton. This realised a net sum of £149.

TANTALITE.

The only output of tantalite in the Pilbara Goldfield, so far, has been in the Wodgina mining centre. The ore, however, is known to occur at a spot about 25 miles east of Wodgina, not far from Green's Well, but no mining has been done in that locality.

Wodgina Centre.

The Anchorite and the M.H., M.Ls. 86 and 87, are held by Messrs. McInnes, Marshall, Mitchell, and Johannsen. On lease 86 a shaft has been sunk 35ft, on a lode dipping about 45deg, east and having a width of about 41/2ft. The footwall is granite and the hanging wall greenstone. The lode is felspar, in which nodules of tantalite are seen distributed. In sinking the shaft, 15cwt. of ore was picked from the broken rock, and it is estimated that there are 10 loads in the dump which will yield 5 per cent. of tantalite. Prior to the lode being found, 3 tons of ore were picked up on the surface. The ore is estimated to contain from 68 up to 72 per cent. tantalic acid. The owners of these claims have been asked to quote a price for 100 tons of 65 per cent. ore. They have done this, but, at the time of my visit, they had not received any reply. As, at present, there is no steady or regular demand for the ore, claim-holders find themselves faced with a rather serious difficulty. They are not, financially, in a position to raise and stack ore for which there is no immediate sale, and on the other hand they are liable to have their holdings "jumped" or forfeited if they are not careful to comply with the labour conditions of the lease.

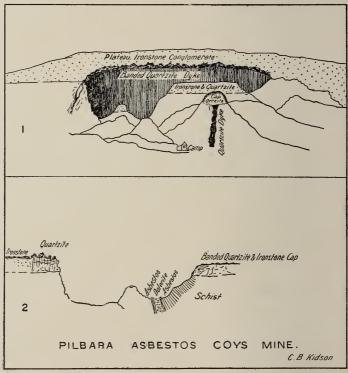
The total output of tantalite ore is as follows:—

From the above Leases, to 31st December, 1908 From Sundry Claims, to 31st December, 1908	Tons. $34 \cdot 10 \\ 51 \cdot 50$	Value, £ 5,445 6,124
Total		£11,569
From H.M. and Anchorite Leases, for eight months ending 31st August, 1909	•45	113
Gross Total		£11,682

ASBESTOS.

Pilbara Asbestos Company's Claims.—These are situated about 25 miles, by road, westerly from Cooglegong, in very rough, hilly country. (Fig. 33.) Two lodes, known as Λ and Β, have been discovered and have been prospected for a considerable length by a series of trenches, pits, and shafts, the latter ranging from 70 to 140ft. in depth. The lodes occur in serpentine rock and lie parallel to one another, and are separated by a diorite bar which forms the footwall of one lode and the hanging wall of the other. The width

Fig. 33.



of asbestos-bearing rock varies from 15 to 36 inches and the percentage of fibre from 10 to 30 per cent., in lengths ranging from half an inch to over six inches. (Fig. 34.) At the 140ft. level of the hauling shaft the lode has been driven upon for an aggregate length of 228ft., and its appearance here is superior to what it is on the surface and for a few feet down. In depth the lode has a tendency to increase in size. At the time of my inspection no work was going on, operations having been suspended pending the Company obtaining expert advice in regard to the machinery to be installed for extracting the fibre from the rock.

Marsh's Asbestos Claims.—These are situated about seven miles south-west from Marble Bar in the rough hills forming the eastern edge of the Main Range, and to the west of the telegraph line from the Bar to Nullagine. They comprise M.Ls. Nos. 164, 165, 166, 167, 168, 169, and 176, aggregating 288 acres. At the present time very little prospecting work has been done in the way of sinking shafts or in tunnelling the hills. But in places where work has been initiated the rock is seen to carry good percentages of asbestos. The veins exposed vary in length of fibre and many are up to half an inch and one inch; the quality appeared to be good.

The surface of the leases shows the asbestos to be distributed over a large area and there can be little doubt in the matter of quantity. Considerable preliminary expenditure, however, will be necessary for the formation of roads through very rough country, sinking wells, or making dams for water supply, grading for machinery, and the installation of plant necessary for extracting the fibre.

In addition to the leases held by the Pilbara Asbestos Company and by Mr. Marsh, there are other localities known to prospectors at which the mineral occurs. But until the question in regard to the necessary plant required to extract the fibre has been settled there is no inducement to take up additional areas of ground.

Up to date no large quantity of asbestos has been exported, the only parcel recorded being 40 tons from the Pilbara Asbestos leases, which was valued at £1,600.

SILVER-LEAD ORE.

There is no record of silver-lead mining in the Pilbara Gold-field but the existence of the ore is known. From Mr. W. A. Snell I learned of a lode having been discovered in the country lying between the Davis and Oakover Rivers at a point described as being, approximately, 90 miles from Marble Bar, and 60 miles from Wallal, on the seaboard. He describes the lode as having been traced for a length of nine miles, and that the ore occurs in bunches. He cut into the lode for about 14ft. and took out a parcel of 3 tons 17dwt. which he shipped to H. A. Watson, of Liverpool, England. The account sales showed an assay value of 50 per cent. lead, 6.85ozs. silver per ton, and 2.62 per cent. copper, of the value per ton of £20 19s.

Table showing Total Quantity and Value of Minerals produced in the Marble Bar District of the Pilbara Goldfield.

61.11.6	11	. 1	1 11: 1					on con co	varue £
Gold from to			dollied, ly, 1909		is, and	ore tre	eated		385,221
								$\operatorname{Tons}.$	
Black Tin,	to	31st	August	, 1909				$4,395 \cdot 44$	363,211
Tantalite								86.05	11,682
Asbestos								$40 \cdot 00$	1,600
			Tota	l Value				_	£761.714

NULLAGINE DISTRICT.

Nullagine Centre.

G.M.Ls. Nos. 119, 120, 121, and 122, are held by the British Exploration of Australasia, Ltd., and are situated on the conglomerate beds. A good deal of prospecting by means of tunnels driven into the hills has been done in past times, but nothing in the way of mining is now going on. A few men are fossicking for goldbearing veins in the old workings, and others are dry-blowing in the gullies. The occurrence of gold in the conglomerate appears to be very erratic, and nothing to indicate any regular run has been found. The highest values appear to mostly occur in those seams and veins that carry a good deal of iron oxide. It is very possible that under a good system of prospecting these beds some more regular line of gold deposition might be discovered and proved to be payable. The best system in this direction would appear to be that of sinking a series of shafts across the beds at certain intervals and from these-after bed-rock had been reached-run out drives and crosscuts and engage in careful sampling. The work so far done on the beds is by no means sufficient for thoroughly testing them, and in extent is very small in comparison to the great area covered by the conglomerate. The country on the eastern side of the Nullagine River shows a large number of quartz reefs, but at the time of my visit no work of any kind was being done on any one of them. In the past times fairly good returns were obtained from the Day Dawn and Victory lines of reefs, and elsewhere in the district. The old workings were practically inaccessible for purposes of examination underground, but from the appearance of the quartz at the surface and from the stated yields one is led to think that further work might be undertaken with advantage.

In the country in the neighbourhood of the Two Dromedaries, and further south near Castle Creek, there are reefs outcropping which deserve to be prospected. Mining appears to have prospered while there were means at hand for crushing the stone raised; but for one reason or another the owners of batteries shifted on to other localities, and reef mining died a natural death.

It is not likely to recover until some crushing plant is erected; but there should be a good opening for the profitable running of one. The old-time charge for crushing was 27s. 6d. per ton, and only the very richest ore could be made to pay at this price. Now that the railway will reduce the cost of supplies and power can be obtained by the use of oil or producer-gas engines in lieu of steam, there should come a revival in mining.

NULLAGINE MINING CENTRE.

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31st	I att	ach a , 1909	table s	showi	ng the	gold yie	ld fr	om this centre up to
		Gold produced for 7 months to 31st July, 1909.	Gold therefrom.	Fine ozs.	 	33.88 4.50 4.50 5.50 5.50 5.50 5.50 5.50 5.50	103.01	
		Gold produ months to 31s	Ore treated.	Long tons.	10.00	 5.00	19.25	
		ecember,	Gold therefrom.	Fine ozs. 88.93	701.61 340.38 10,065.42	8,111.74	19,308 · 08	028. 1104.70 111.45 19,411.09 19,627.24
	9.	up to 31st D 1908.	Ore treated.	Long tons.	1,658.00 4,5.50 4,946.25		11,215.75	19 16 16 16 17:
CENTRE.	July, 190	Total Gold produced up to 31st December, 1908.	Dollied and Specimens.	Fine ozs.		97.49	111.45	t July, 19
MINING	ed to 31st	Total G	Alluvial.	Fine ozs.	::::	104.70	104.70	ced to 31s
NULLAGINE MINING CENTRE.	Total Gold produced to 31st July, 1909.		Registered Name of Company or Lease.	British Exploration of Australasia, Ltd	Grant's Hill	yanide)	Totals	Alluvial Dollied and Sperimens Ore treated, long tons—11,235.00 Gold therefrom, fine ozs.  Average yield per ton of stone treated (exclusive of Alluvial, Dollied, and Specimens)
			No. of Lease.	G.M.Ls. 119, 120, 121,	G.M.L. 122		: · · · · · · · · · · · · · · · · · · ·	

# Total Gold produced to 31st July, 1909.

0.401	: : : : :	: : : :	fine ozs 19,411·09	Total, fine ozs 19,627·24	Access and the second and the second second and the second
Alluvial	Dollied and specimens	Ore treated, long tons-11,235.00	Gold therefrom, fine ozs	Total, fine oz	

### Middle Creek Centre.

The Barton Mine.—This mine is on a boldly defined line of reef which outcrops for over 1,200ft. in length along the surface. It has been worked to a depth of 150ft. and for over 350ft. in length at the lowest level. Other shafts and drives have been opened south of the main workings, and the principal work has been done in underlay shafts.

The main shaft, at which a small hoisting winch has been installed, has a depth of 173ft. and reef and lode formation at that depth are about 10 to 15ft, wide in the aggregate. No driving has been done in a north-easterly direction, but south-westerly a drive has been extended for 350ft. A strong quartz reef has been left standing on the westerly, or footwall side of the drive as it did not prove to be payable where prospected, though it carries gold throughout. Its actual width has not been determined. The country at this depth is a soft schist. This stands strongly and well while dry, as in the upper levels, but here below water level it is weak and the drive has had to be timbered with legs and cap sets. At about 200ft. from the vertical shaft a crosscut was driven east 6ft. and another lens of stone was met with and proved to be 18 inches This was stoped to the 110ft. level for a length of 200ft., giving 1,250 tons of ore of an average value of 27 to 28 dwts. per ton. This is distinctly a lens of quartz lying parallel to the main lens and separated from it by 6ft. of schist. A winze has been sunk on the reef for 26ft.; its width of 18 inches is maintained and the ore obtained from it is stated to have vielded 22dwts. by battery amalgamation, its gross assay value being given at 32 to 34 dwts. per ton. At about 250ft. from the shaft the main drive has been deflected on to the course of the eastern reef and follows that to the end. The face exposes 4in. of quartz. This drive should be extended as, judging from the surface, it is almost certain that an additional lens will be found to extend south-westerly. The reef is portion of a lode formation composed of schist and small veins of quartz, but is reckoned too poor to pay the present owners under the existing conditions of work. The inflow of water per day is estimated to be 1.500 gallons and is suitable for steam purposes. It forms a sediment but no scale. Each week two bags of Mountain Gum bark are thrown into the feed water. The boiler is cleaned out bi-weekly. From the 110ft, level to surface a strong lens of stone has been stoped out at those points at which the highest values were met with, but there appears to be a good deal of stone remaining which is estimated to be worth 7 to 8 dwts. per ton. In some places the reef was from 5 to 6ft. wide.

Up to the end of July, 1909, this mine has yielded 5,973.56 fine ozs. gold from 4,581.65 tons of ore, or an average yield of 1.30 ozs. per ton. This includes the gold from scaling the plates, and from treating 400 tons of battery sands by cyaniding. The cyaniding extraction from the above parcel was 26ozs. fine gold per ton.

A ten-head battery, with engine, Berdan pans, etc., and a cyanide treatment plant consisting of four 20-ton vats, is situated on the highest point of the hill which the reef outcrops.

The main hauling shaft is at the foot of the outcrop, almost on a level with the plain, and at some distance from the battery. All ore raised at the shaft had to be extensively handled into drays and carted to the battery, thus involving very considerable expense which might have been obviated quite easily. From the surface indications I should estimate that the ore channel on this mine was from 100 to 150ft. in width. In addition to the main reef there are two more well defined reefs outcropping to the eastward, and free gold has been prospected in at least one of these. The mine is one that should be well worth being properly developed and opened up by further sinking and crosscutting. All the surface plant, also, requires to be re-arranged so as to secure economy in handling ore, etc.

At the time of my visit only two men were employed. Owing to the death of one of the owners and the necessity for realising his estate, an attempt was being made to dispose of the mine.

At about a quarter of a mile from the Barton mine, in a northeasterly direction, the line of reef is faulted by an intrusion of ironstone and copper ore, the latter showing freely as blue and green carbonate.

Beyond this the reef continues on to the old *Hopetoun Mine*. This is now being worked as a quartz claim, No. 397, by Kinsey and Nestid. Nothing more than surfacing is being done and fossicking in the old workings. The outcrop of quartz is bold but an open-cut shows a series of small veins of quartz dipping easterly at a low angle. The country rock is schist, very twisted. The values met with by the present workers vary from 3 to 10dwts. per ton, but it is said that in past times some very rich patches were obtained. The distance to the State battery is  $5\frac{1}{2}$  miles and cartage costs 2s. per ton per mile.

The All Nations Extended.—This is a quartz claim held by James Glen, who is working it single-handed. The reef has the usual north-east strike but where exposed in some workings it dips 65deg. west, and therefore across the dip of the country, which is easterly. The reef and lode formation has a width of from 4 to 5 ft. composed of quartz and ironstone veins. The owner is following a small vein along the footwall, which is stated to be worth 2ozs. gold per ton. At about 100ft. from the surface the lode becomes almost vertical.

The Federation Mine (G.M.L. 173L) is held by John S. Potts. The reef outcrops along the crest of a hill and is now being worked from a tunnel that has been driven from the northern side to crosscut it. The reef strikes north-east and dips easterly at about 60 deg. In width it varies from a few inches up to 9ft. About 100ft. of driving on the reef has been done, and at the present time a

### MIDDLE CREEK MINING CENTRE. Total Gold produced to 31st July, 1909.

winze is being sunk from the level and is down about buil, at
which depth the reef maintains its width as in the upper level. The
owner states that occasional shoots of ore, from 12 to 15 feet in
length, have yielded very well. In places the reef has been mined
right up to the crest of the hill. At the present time there are
about 40 to 50 tons of ore at grass estimated to be worth from
1 to 2 ozs. per ton. The official record of this mine, up to the end
of 1908, shows a yield of 154.70ozs. gold from 44.25 tons of ore.
Elsewhere in this centre very little work was going on in addi-

tion to the above mines, and what there was was chiefly in the form of fossieking in old workings.

I attach a table showing the total gold production from the mines hereabout up to 31st July, 1909.

Fine ozs. 30·10 169·44 107·71 82.67 415.22 Total Gold produced for seven months to 31st July, 1909. Gold therefrom. 5.0077.75Long Tons. 51.00 69.25 133.00 Ore treated 00.00 47.00 Cvanided. Tons. Total Gold produced to 31st December, 1908. 46.56 154.70 3,215.58 471.36 160.25 .. 44.95 Fine ozs. 5,395·41 9.542.64 herefrom. 46.00 44.25 751.00 195.50 5,770.90 Long Tons. 4.530.65 Ore treated Little Wonder West Registered Name of Company or Lease. Sundry Claims Voided Leases Groves and party Clarke and party Barton (Plates) Rederation Ves-No Eureka. No. of Lease.

Do. 172L 173L 13SL 168L 136L

Total Gold produced to 31st July, 1909.

0.C. 391 L.C. 393

Nil	<i>n</i> _N · · ·	9,957.86	9,957.86	1.68 fine ozs.
	•	:	:	
•	•			
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: :	:	:	:	:
:	:	:	:	
:	:	:	:	:
Alluvial	Dollied and Specimens	on a	Tital, fine ozs.	Average yield per ton of ore treated

### Twenty-Mile Sandy Centre.

The Mountain Maid Mine lies about two miles easterly of the State Battery in this district. The mine is situated at the top of a hill in schist country, which is very much twisted and disturbed. The reef evidently conforms with the folds of the schist and forms a series of saddles and reverse-saddles which make it a rather perplexing proposition to work until thoroughly understood. At the time of my visit apparently two reefs were exposed in one of the levels, which had the appearance of dipping towards one another. A crosscut had been driven at a lower level in the expectation of cutting into a large body of ore, but no sign of reef was met with; the crosscut had evidently passed below the point representing the trough of reversed saddle. The present owners, Triat and Son, have been only 12 months at work, and are getting out stone for crushing. The official record for this mine shows that up to the end of July, 1909, 127.00 tons of stone had yielded 399.87ozs. of gold.

With the exception of some quartz claims and prospecting

areas, there is no other mine working in this district.

I attach a table showing the total gold produced in the neighbourhood up to 31st July, 1909:—

	Total Gold produced to 31st July, 1909.	oduced	to 31st	July,	1909.		
No of	Romistored Name of	Total 31st 1	Fotal Gold produced to 31st December, 1908.	need to 1908.	Gold-pr months t	Gold-produced for seven months to 31st July, 1909	r seven ly, 1909.
Lease.	Company or Lease.	Dollied and Speci- mens.	Ore treated.	Gold there- from.	Cyan.	Ore treated.	Gold there- from.
167L Do C.C. 379 O.C. 399 C.C. 391 C.C. 394 C.C. 395 C.C. 396 C.C. 39	Mountain Maid  do.  Yoided Leases Sundry Clains Houlton and party do.  Groves and party do.  Bayer, B.  do.  Dunn and party Reward Claim Biee and party	Fine ozs.	Tons. Fine ozs. 2,240bs. 268·70 268·70 375:95 480·77 1,671·90 2,901·55	Fine ozs. 268 · 70	Tons. 2,240lbs. 14.00 44.00 8.0 53.5	Tons. 2,2401bs. 2,2401bs. 20 00 00 00 00 00 00 00 00 00 00 00 00	Fine ozs. 105 +8 105 +8 105 +8 105 +8 105 +8 105 +8 105 +1 19 105 105 105 105 105 105 105 105 105 105
	Totals	14.36	14.36 2,154.85 3,651.02	3,651.02	:	99.50	226 · 12

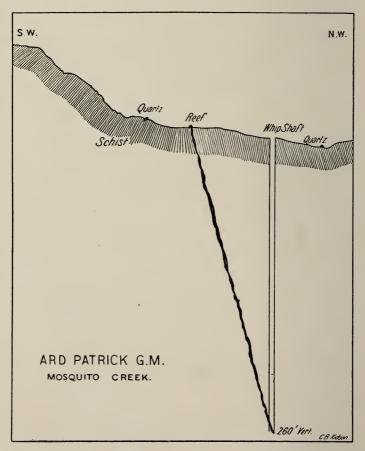
TWENTY-MILE SANDY MINING CENTRE.

					ozs.
	Nil		3,877.14	3,891.50	1.72 fine ozs.
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Gold			2,2,2	Total	of ore
tal	:	mens	tons, ne o;	-	ton
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		pu	ea, refro		rield
Total Gold produced to 31st July, 1909.	Alluvial	Dollied a	Ore treated, long tons, 2,254.35 Gold therefrom, fine ozs		Average yield per ton of ore (exclusive of Dollied and Specimens)
	-4	-10	-		- 1

### Mosquito Creek Centre.

The Ard Patrick Mine, G.M.L. 143L.—The owners are Messrs. Boyer, Underwood, and Priest. Six men are employed inclusive of

Fig. 34.



the manager. The reef strikes N.E. and S.W., and dips north-westerly 65 to 70deg. A vertical shaft has been sunk 260ft., and the

lowest working level is at 250ft. At this point a drive on the reef in a north-easterly direction has been extended 35ft. The width of reef as exposed in the drive ranges from 24 to 36 inches, and appears to be widening under foot. I was informed that from this level a crushing of unselected ore aggregating 27 tons yielded 2ozs. 16dwts. per ton by battery amalgamation, and the assay value of the sands was 27 dwts, per ton. A second parcel of 52 tons yielded 2ozs. 1dwt. per ton, and the sands assayed 11dwts. 19grs. per ton. (Fig. 34.) At a depth of 80ft. from surface the length of ore mined for the battery was 20ft., and at 130ft. it was 70ft. in length. The length at the lowest level is not yet known. The quartz is stained with iron oxide and also carries a little iron pyrites.

Scheelite is met with in the reef, but mostly towards the western end of the property. The enclosing country is a soft tough schist which stands well with a minimum of timber. But it is probable that if the mine was more vigorously worked and heavier and more frequent blasting carried on additional timbering would be found necessary. At present the workings are all well secured and apparently safe. The ladder way down the incline shaft and through the rearings at the ends of the stopes is in good condition.

The surface shows, by out-crops and quartz, that there are reefs parallel to the one now being worked. But no crosscut has been cun out from any level in the mine to prospect any of these. It is curious that this development should be overlooked. In the very possible event of one or more of these reefs proving payable, the owners would greatly increase their possible output of ore and at very little additional expense for development. As evidenced by surface indications, the schist dips both east and west, and it is probable that the reefs occur in saddle-formation. A succession of saddles may be found as sinking is carried on.

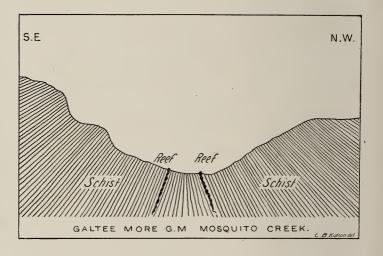
The officially recorded output from this mine is 637.75 tons of ore, yielding 2,127.91 fine ozs. of gold, or an average of 3.33 fine ozs. per ton.

The Surprise Mine lies to the west of the Ard Patrick, but was not being worked when I visited the district. Up to the end of last July the output is given as 246.25 fine ozs. of gold from 101.50 tons of ore, or an average of 2.42 fine ozs. per ton.

The Galtee More Mine, G.M.Ls. 79L and 145L.—Owned by Messrs. Boyer, Connelly, and Dunn. The main reef, or the one that has been most worked, presents the same strike and general characteristics as the Ard Patrick. (Fig. 35.) It is lens-shaped and varies in width from a few inches up to 36 and 48 inches. What is known

as the west shaft has been sunk 235ft., and the line of reef has been worked by a series of shafts and open-cuts along a length of about 600ft. At the present time a parallel reef is being worked. This is found to have an easterly dip, or the opposite to that shown in the main reef. It appears to be one side of a saddle, the apex of which has broken away. A vertical shaft was sunk 100ft. to intersect it, and thence the shaft followed on its incline for a further 70ft. The width varies from 24 to 36 inches. From this shaft about 100 tons of ore were being carted to the State Battery; the owners estimate it to yield from 25 to 30dwts. per ton. The official records up to 31st July of this year show that the total output from these leases

Fig. 35.



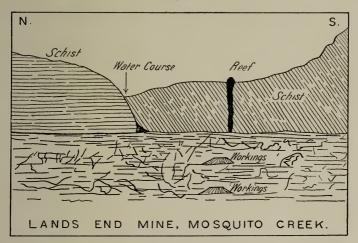
has been 1,682 tons for a yield of 3,817 fine ozs, of gold, or an average of 2.26 fine ozs, per ton. About four men are employed. The cost of cartage to the battery, a distance of seven miles, is from 7s. 6d. to 10s. per ton.

At about three miles easterly from the Galtee More mine I visited a small group comprising the Off Chance, the Land's End, and the Belle Vue mines.

The Off Chance.—The old workings have been abandoned, but along the same line of reef Messrs. Martin, Finney, and Aikman are engaged in prospecting. At the time of my visit very little fresh work had been done. At one point a small, but perfect, saddle reef has been disclosed.

The Land's End Mine.—This is at present abandoned, but at one time some very rich ore was raised. (Fig. 36.) The reef shows strongly on the hill to the east of the main workings, but going

Fig. 36.



westerly its course has been faulted and much disturbed. It was at this point that the rich ore was got, but the workers became disheartened at not being able to follow the reef, and stopped working.

The Belle Vue Mine.—This is practically abandoned, there being only one man fossicking in the old workings. The country hereabouts is greatly disturbed and faulted.

The Parnell Group.—These mines are quite abandoned. It is stated that there are large quantities of ore in sight, but that the value was too low to permit of profitable work without a battery on the ground.

### Cook's Creek.

I was not able to visit this locality, but gained the following information from Mr. Toohey, who, with Messrs. Wilson and Thompson, are working on P.A. 9. The claim is about six miles east of the Mosquito Well. A shaft has been sunk 20ft. on a reef varying from four to 36 inches in width. It has a nearly east and west course, and dips south about 45deg. One crushing of 15 tons is stated to have yielded at the rate of 2.10ozs, of fine gold per ton. A second parcel is in course of being treated.

I attach a table showing total gold produced in this centre.

### MOSQUITO CREEK MINING CENTRE. Total Gold produced to 31st July, 1909.

					The same of the sa					
1				Total Go	Total Gold production to 31st December, 1908.	to 31st Decem	ber, 1908.	Total Gold p	Total Gold produced for seven months to 31st July, 1909.	ven months
No. of Lease.	Registered Name of Company or Lease.	of Company	y or Lease.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Cyanided.	Ore treated.	Gold therefrom.
143r.	Ard Datriol.			Fine ozs.	Fine ozs.	Long tons.	Fine ozs.	Tons.	Long tons.	Fine ozs.
	do.	: :	:	:	:	00.800	1,928.86	00.01	79.25	177 - 90
95L, 109L	Bell Extended Co., Ltd	o., Ltd	: :	: ;	: :	:		00.01	:	c1.12
109L	Federal	:	:	:	: :	48.00	56.46	: :	: :	:
79L	Galtee More	:	:	:	:	286.00	1,648.33	: :	106.00	188.85
Do		:	:	:	:	:	:	00.92		19.84
791, 1451	Galtee More Leases	ses	:	:	:	00.066	1,959.98		: :	:
1217	Land's End	:	:	1.70	:	96 · 20	327 - 71	19.00	:	3.91
	Latest Surprise	:	:	:	21 - 42	108.00	147.74	:	101.50	76.36
OEI	do	:	:	:	:	:	:	02.29	:	22.15
der	Farnen	:	:	:	:	357.35	366.08	:	:	:
05r 100r	Dengell I const	:	:	:	:	196.50	87.75	:	:	:
near tree	rainch Leases	:	:	:	:	1,815.00	1,736.09	:	:	:
	Sundry Claims	:	:	:	1,000	1,090.00	1,866.00	:	:	:
L.C. 370	Bill T	:	:	:	74.001	1,800.44	2,633.65	:	:	:
L.C. 386	Trevan. B.	: :	:	:	:	:	:	62.21	:	1.63
P.A. 5L	Baldwin and Cameron	neron		:	:	:	:	07.5	:	20.T
P.A. 9	Bice and Toohey	: :	: :	:	:	:	:	:	00.01	02.46
L.C. 391	Groves and party	Λ			:	:	:	0 11 0	00.eT	60.Te
186L	Felle Vue	:		:	:	:	:	ne.e	:	00.
R.C. 388	Litta			:	:	:	:	:	00.0	SI. Ti
		:	:	:		:	:	:	56.00	17.80
	Totals	: :	:	1.07	187.89	7,706.49	12,759.00	:	338 - 75	578.78

Total Gold produced to 31st July, 1909.

1.07	187.89	13,337.78
:	:	:
•	:	:
:	:	:
:	:	:
:	:	:
:	:	:
Alluvial	Ore treated, long tons—8.045.24	ine ozs.

Average yield per ton of ore treated (exclusive of Alluvial, Dollied, and Specimens)-1.65 fine ozs.

.. 13,526.74

### State Battery at Twenty-Mile Sandy.

This 10-head battery was erected in the hope that it would materially assist in the development of the Mines in the surrounding districts. At the present time the total number of mines producing ore within range of the battery is 11, giving occupation to 27 men, inclusive of working owners and managers. Crushing commenced in May, 1905. Up to the 14th August, 1909, the total quantity of ore supplied to the battery was 5,357.60 long tons, or an average of 3.98 tons per working day over the whole of the period. For each year the supply works out as follows:—

Ye	ar.	Days.	Total tons supplied.	Average daily supply, tons.
1905		 209	1,652 · 35	7 · 90
1906		 313	1,141.50	3.64
1907		 313	$1.061 \cdot 50$	3 · 39
1908		 313	820 · 25	2 · 62
1909		 196	$682 \cdot 00$	3.47
Total	••	 1,344	5,357.60	3.98

This is an absurd result in view of the ore that could have been supplied by the mine owners had they undertaken their work seriously. Taking the days in 1909 it shows that the ore supplied by 27 men amounted to only 2,56cwt. per man per day! This does not look like arduous labour on their part nor economical management on the part of the owners and managers. To the State it signified a heavy loss in wages, fuel, and stores at the battery. Results such as these are not likely to make the Government respond eagerly to applications for the erection of crushing plants. Nor do they go to show that the installation of this particular battery has had any vital effect in promoting the development of the mines.

### Eastern Creek Centre.

This comparatively new mining centre lies about 16 miles distant by road from the Government well at Mosquito. A much shorter track, doubtless, could be found without much trouble. The road at present used follows King Creek in a N.N.E. direction for about nine miles, then N.E. for about three miles to where Cook's Creek is crossed, and thence almost due easterly for about four miles. The country passed through from Mosquito to Cook's Creek comprises steep hills of schist, in which occur numerous outcroppings of iron-stained quartz reefs. Of these very few have even been knapped, though their appearance should induce prospectors to carefully test them.

From Cook's Creek crossing the track runs sharply upward, and enters the belt of country in which the workings are to be met with. The hills are very steep, and are separated one from the other by deep gorges, and only are they in a few instances connected by saddles. The various workings are situated on, or near, the summits of these cones, and to visit means a steep climb, and a descent which is less pleasant than the climb. The highest point in the ranges—just at the back of the camp—appears to be about 300 feet above

the crossing at Cook's Creek, and the adjoining hills rise to one or two hundred feet more or less. The main lines of range have a trend about N.E. and S.W.

The strip of country in which the gold-bearing reefs have been located has a width of about half a mile, and is bounded on the northern and southern sides by high serrated ranges of quartzite with which are associated masses of conglomerate and ironstone. The quartzite shows, occasionally, a banded structure.

The conglomerate in places overlies the dykes, but as a rule it is found lying on the hanging wall side of the quartzite, and more or less fractured. To the north of the camp where the creek cuts through the hills, the conglomerate is seen resting on its edge on the schists.

The schists dip to the southward, and have a course a little north of east, and are traversed by small dykes of greenstone and sandstone striking a more northerly course.

The quartz reefs are numerous, and outcrop along the sides of the hills. They dip southerly, but their strike does not closely conform to that of the country but takes a slightly more northerly direction. On the northern side of the belt the reefs come in contact with the main dyke, and on the Reward lease the reef passes into the dyke, follows its course for some distance, and then passes out to the north-east through the dyke. In width the reefs vary from a few inches up to three and four feet. The quartz carries a good deal of ironstone, some of which is haematite, but more frequently in the form of a gossan. This last-named ore fills cavities in the quartz, and frequently is very rich in gold. The gold is very fine in form, more especially when in the gossan; it occurs also in solid quartz, and then is in much coarser particles.

Twenty-one men are in the camp, of whom 15 comprise some of the shareholders and employees of the Eastern Creek G.M. Co., and the balance are other claim holders, woodcarters, etc. The company hold four leases, viz., the Rose, Harp, Crescent, and Reward, aggregating 30 acres. It has erected a 10-head battery of 800lb. stamps, driven by an engine and Cornish boiler. The importation of this into such hilly country was a matter of difficulty and expense, but by its erection it was possible to treat a grade of ore that otherwise must have been thrown to one side, if earting to the 20-Mile Sandy State battery had been necessitated. For some time past there has been a lack of water, and at one time the supply for the battery had to be supplemented by cartage by bullock teams from Cook's Creek, four miles distant. At the present time a cyanide plant is in course of erection, and the accumulated sands will be treated.

Owing to the steepness of the hills the transport of ore from the mines to the battery is a matter of some difficulty and expense. The flying-fox method is undoubtedly the best adapted to the situation, but considerable capital would be required to furnish each mine with this mode of conveyance. At present camels are employed. Paths are cut along the sides of the hills on a suitable grade, and the camels carry five or six hundredweight of ore in green hide pack bags. At this work they have been found to be very sure footed, and only in one instance has a camel fallen. The cost of transport in this fashion is stated to be 7s. 6d. per ton. Firewood is at present very plentiful, and is delivered at the battery at from 25s. to 30s. per cord.

The Shamrock Mine (G.M.L. 178L, 6 acres) is owned by Messrs. Edmen and Chavi. A series of open cuts have been made on the reef to depths of eight to 10 feet, showing widths of stone from six to 12 inches. The quartz is dark in colour, and in places carries fair sized crystals of pyrites, commonly known as "Devil's Dice." Towards the north-east boundary of the lease a pipe of ore five feet in length and from three to four feet wide was followed down to a depth of 10 or 15 feet, and is stated to have given good results. Up to the end of July, 1909, two crushings have been taken from this mine. The official records show, 14.25 tons for a yield of 71.55 fine ozs., and 80.00 tons for 103.01 fine ozs., a total of 94.25 tons for 174.56 fine ozs., or an average of 1.85 fine ozs, per ton. The cost of crushing at the Eastern Creek G.M. Cov.'s battery is 30s, per ton. Cartage is low, as the battery is only a few hundred yards or so from this mine. At the foot of the hill a vertical shaft has been sunk 102 feet 6 inches by 3 feet 6 inches in the clear. The object of sinking was water, but none was met with at this depth. Down to 40 feet the schist was soft, and in colour brown. Below this it changed to an almost black colour. Boring was hard, but the rock broke well in firing. The shaft is timbered for about 9 feet from the top of the dump. The sinking was done by four men in 8½ weeks. Wages £4 10s. per week per man. Total cost of explosives for the total depth, £15.

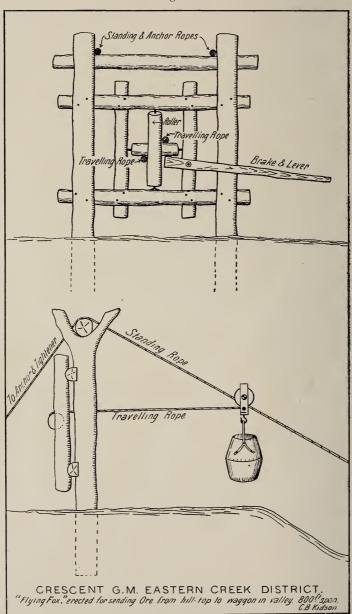
The Eastern Creek Gold Mining Co.—The chief shareholders in this are Messrs. Garland, Walker, Nickols, Watson, and Doherty. The company own the Rose, G.M.L. 179L, the Crescent, 180L, the Harp, and the Reward, 176L, having an aggregate area of 30 acres.

The Rose Mine.—The workings consist of a number of open cuts on a reef outcropping near the summit of the hill. The quartz shows in small lenses. The country is faulted and disturbed. The maximum width of lens is about 12 inches. The official returns to end of July, 1909, show that a total of 32 tons of ore yielded 23·54 fine ozs. of gold.

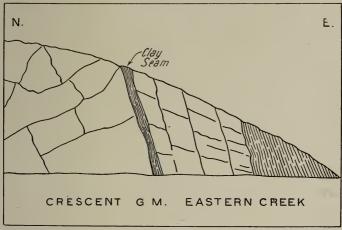
The Thistle.—This claim adjoins the Rose on the Western boundary. No work was going on at the time of my visit. The official records show that up to end of July, this year, 33.50 tons were treated for 25.84 fine ozs., and 22.50 tons of sand cyanided for 7.18 fine ozs., or a gross average yield of a little over one oz. per ton.

The Crescent Mine is the most westerly of the group. Near the summit of a hill an open cut exposes small veins of quartz in very disturbed country. Towards the southern side of

Fig. 37.

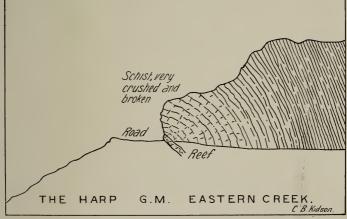


the lease at the foot of the hill a tunnel has been driven on the course of a reef for 64 feet. The reef is 6 to 15 inches wide, dipping easterly at an angle of 15 to 20 deg. The quartz shows char-Fig. 38.



acteristics similar to those of the reefs above described. (Fig. 38.) The official record at the end of July of this year shows a yield of 774.70 fine ozs. gold from 407.75 tons of stone crushed, and 8.03 ozs. fine gold from 8.50 tons of sand cyanided, or a total 752.73 ozs. fine gold.

Fig. 39.

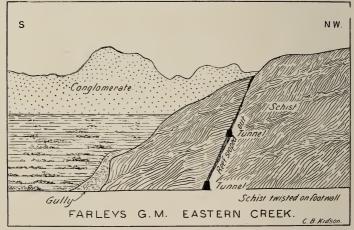


The Harp Mine.—This is being worked by open cut on the reef outcropping along the northern slope of a hill, the reef dipping into the hill. (Fig. 39.) I was informed that five tons of stone had been crushed for a return of 27dwts. per ton by amalgamation, and

the gold contents of the sands not then known. This crushing must have been subsequent to the end of July, as it is not included in the returns to that date.

The Reward Claim.—The chief reef on this claim outcrops along the south-easterly slope of a hill which is crested with a banded quartzite dyke lying against which is a mass of conglomerate tilted in conformity with the incline of the dyke. The reef is well defined for a width of 36 inches. Its course is N.N.E.-S.S.W., and dips south-easterly at rather a low angle. In its N.N.E. course it crosses a gully, and makes directly for the quartzite dyke on top of the hill. Upon touching this it appears to follow and become mixed with the dyke for some distance, ultimately passing through it, and contining on into the Morning Star lease adjoining. The quartz is of the same appearance as that in the above mines described. The official records to end of July of this year show that 21.50 tons treated by amalgamation have yielded 68.07 fine ozs. of gold.

Fig. 40.



The Morning Star Mine (G.M.L. 182L) is held by Mr. Farley, and comprises 12 acres. It adjoins the Reward Claim on the northeast, and appears to be a continuation of the Reward reef. (Fig. 40.)

On the crest of the hill the reef is in conjunction with the quartzite, and is considerably broken. But towards the further end of the claim another reef is being worked which outcrops on the northern slope of a hill, and is much more settled and regular in its course than the Reward reef. This reef is being worked upwards from the level of a creek bed.

The official records show, to the end of 1908, that a crushing of 25 tons yielded 113ozs, of fine gold.

I attach a table showing the total yield of gold from this centre up to 31st July, 1909.

## EASTERN CREEK MINING CENTRE.

## Total Gold produced to 31st July, 1909.

uced for seven t July, 1909.	Fold therefrom.	Fine ozs. 889-21 8-03 8-68 103-01 133-31 5-45 25-54 7-18 16-31 16-31
Total Gold produced for seven months to 31st July, 1909.	Ore treated. Gold therefrom	Tong Tons. 325.00 80.00 20.00 32.00 10.00 10.00
December,	Cyanided.	Tons.  6.50  8.50  14.50   22.50
Total Gold produced to 31st December, 1903.	Ore treated. Gold therefrom	Fine ogs. 855-69 855-69 133-70 71-55
Total Gold p	Ore treated.	Long Tons. 82-75 13-00 25-00 14-25
		:::::::::::::::::::::::::::::::::::::::
P2SP		:::::::::::::::::::::::::::::::::::::::
or L	! ;	:::::::::::::::::::::::::::::::::::::::
Baristored Name of Comnany or Lease.		:::::::::
of C	5	
Na meX		:: _p ::::::; _è
istered		's Reward Star ck
2		Crescent Doberty's Ray Morning Stantock Olive do. Rose Thistle do. Clifford and
	;	:::::::::
O O Toose	Trows	:::::::::
No ox		1801
		1801. Do. 1761. 1781. 1781. 1871. Do. 1791. Do. R.C. 3

## Total Gold produced to 31st July, 1909.

Nil	$n_N$	1,200.69	1,200 · 69	1.88 fine ozs.
:	:	: '	: '	:
:	:	:	:	:
:	:	:	:	:
:	:	: :	:	:
:	:	:	:	:
:	:	:	plog	:
:	Dollied and Specimens	Gold therefrom, fine ozs	Total ozs., fine gold	Average yield per ton of ore treated

### PILBARA GOLDFIELD.

### NULLAGINE DISTRICT.

# Table showing Total Ounces produced in each Mining Centre up to 31st July, 1909.

and tens. T. 27.89 1.45 1.45	N. C		Ore treated.  Long tons.  135.00  720.00	Gold therefrom.  Fine ozs. 600·13 1,340·70	Dollied and Specimens.	Ore treated. Long tons.	Gold therefrom. Fine ozs.
Fine ozs.   Fine ozs.   Line ozs.   Fine ozs.   Line	Fine ozs	\	ong tons. 135 · 00 428 · 25	Fine ozs. 600-13 1,340-70	Fine ozs.	Long tons. 500.50	Fine ozs. 690-56
k  1-07 187-89  1-107 187-89  1-108 104-70 111-15  111-15  111-15  111-18	1.07	:::	135 · 00 428 · 25 770 · 00	600.13	: :	200.20	690.56
k	1.07	::	428.25	1,340.70	:		
k 1.07 187.89 104.70 111.45 1 areals treated at	1.07	:	770.00			:	
k	104.70		06.01.6	9,542.64	:	133.00	415.22
arcels treated at :	104.70	187.89	7,706.49	12,759.00	:	388.75	578.78
aveels treated at:	61 101	111-45	11,215 75	19,308.08	:	19.25	103.01
: : :	:	14.36	2,154.85	3,651.02	:	99.50	226.12
	:	:	:	199-99	:	:	:
Royer's Public Crushing Works	:	:	:	7.53	:	:	:
State Battery, 20-Mile Sandy	:	:	:	152.46	:	:	77.16
:	:	:	20.20	2,407.85	:	:	26.30
Reported by Banks and Gold Dealers 4,502-45 22.50	+	22.50	:	:	173.01	:	:
Totals 4,608.22 386.20 27,46	4,608.22	<u> </u>	27,461.74	49,969 40	173.01	1,091.00	2,027.15

# Total Gold produced in Nullagine District to 31st July, 1909.

65	.50		.55	86.
4,781.23	336		51,996.55	57.113.98
:	:		:	;
:	:		:	:
:	:		:	:
:	:		:	:
:	:		:	.52
:	:		:	fine (
:	• 1	28,552.74	:	Total, fine ozs
Alluvial	Dollied and Specimens	Ore Treated, Long Tons,	Gold therefrom, fine ozs	

Average yield per ton of ore treated, exclusive of Alluvial, Dollied and Specimens, 1.82 fine ozs.

### PILBARA GOLDFIELD.

Table showing Total Quantity and Value of Minerals produced.

							Marble Ba	Marble Bar District.	Nullagine District	District.	Tot	Totals.
Mineral							Quantity.	Value.	Quartity.	Value.	Quantity.	Value.
Gold, from all sources to 31st July, 1908			:	:	:	:	Fine ozs. 90,688·69	385,221	Fine ozs. 57,113.98	242,604	Fine ozs. 147,802.67	£ 627,825
Black Tin. to 31st August, 1909 Tandalile, to 31st August, 1909 Asbeslos, to 31st August, 1909	:::	:::	:::	:::	:::	:::	Tons. 4,395.44 86.05 40.00	363,211 11,632 1,600	:::	:::	Tons. t,395 44 \$6.05 40.00	363,211 11,682 1,600
Totals	:	:	;	:	:	:	:	761,714		242,604	:	£1,004,318

### WEST PILBARA GOLDFIELD.

On this field I visited the mining centres of Pilbara, Station Peak, Whim Creek, and Weerianna. In the remaining centres no mining of consequence was in progress.

### Pilbara Centre.

The total number of men employed here is 13, of whom 11 are working on alluvial ground. The only lease being prospected was that known as *Pilbara Broken Hill*, G.M.L. 146 (20 acres), owned by Albert Kost. The lease contains a low hill which is crowned with a wide mass of quartz. This appears to be the result of the overflow of the outcrops of several medium-sized reefs, and is not the crest of one large reef. The course of the reefs is north-northeast and south-south-west with a westerly dip of about 40deg. They occur in greenstone country and close to the line of contact with the granite country. Tongues of granite have obtruded into the greenstone, and the whole hill shows signs of considerable disturbance.

A good deal of open-cut work and prospecting has been done in past times along the hill. It is said that patches of very good stone were occasionally met with. The reef, as seen in open-cuts, has a width up to 36in. Below one of the cuts the owner has sunk a shaft 30ft. vertical. The reef was passed through at about 20 to 25 feet from surface, and at that point was not as strong as at the surface. Below the reef was a lode formation consisting of small veins of quartz and ironstone. This is said to give fair prospects in free gold. From the bottom of the shaft a crosscut has been driven 15ft. and a rise put to tap the reef. At the point where touched by the rise coarse gold was met with.

This lease deserves to be carefully tested, and at present very little is known of the average value of the great quantity of quartz exposed on the surface. It is also probable that gold-bearing lodes will be discovered. It would be well to sink the shaft deeper and crosscut easterly into the hill.

The following table shows the total gold produced up to December 31, 1908:—

No. of Lease.	Registered Name of Company or Lease.	Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.
146	Pilbara Broken Hill Voided Leases Sundry Claims	fine ozs 1.11	fine ozs. 48·12  86·24	long tons.	fine ozs. 293.42
	Total	1.11	134 · 36	148.00	293 · 42

Total fine ozs., 428.89.

Average yield per ton of Ore treated, exclusive of alluvial, dollied, and specimens,  $2\cdot 89$  fine ozs.

### Station Peak Centre.

The only lease at which work was in progress was the Pilgrim's Rest, G.M.Ls. 117 and 118, owned by Messrs. Bull Bros. Up to the end of 1908 the official records show that from these leases 9,993 tons of ore were treated for a yield of 9,382.90 fine ozs. of gold, or an average of .93 fine ozs. per ton. At the time of my visit no mining was in progress with the exception of treating the heap of battery tailings by evanide. I did not ascertain the assay values of these, but one of the owners informed me that they were getting an extraction of 75 per cent, of the contents. On the ground is a good 20-head battery of 850lb, stamps, and other plant. The stoppage of this was caused, I was informed, by the scarcity of firewood, the cost of supply having risen to £400 per month, and by the sudden failure of the water supply. This last is obtained from a shaft 105ft, deep at the foot of the hill below the battery. The supply for the cyanide plant was raised by bailing with a horse whip. A good deal of work has been done on a large solid reef which outcrops for a good length along the side of a hill. The reef is a lens formation, and attains a maximum width of about 20ft. The greatest depth attained is in a vertical shaft sunk nearly at the foot of the hill to a depth of 132ft. The reef was passed through at 100ft, but no development has been carried on. The owners are now considering plans for more systematic development and the substitution of oil or gas engine power at the battery in lieu of steam. There is a large quantity of ore in sight, the value of which is estimated at 6dwt. per ton. The mine appears to be one that would develop into a good paying proposition if properly handled. The fuel difficulty can be overcome with no great expense, and probably a plentiful supply of water will be obtained when the reef is opened at a greater depth.

Table showing the total Gold produced up to 31st July, 1909.

Gold produced for seven months up to 31st July, 1909.	Ore treated. Gold therefrom.	Fine ozs
ed for seven 31st July, 19	Ore treated.	Tons.
	Alluvial.	Fine ozs: .: .: .: .: .: .: .: .: .: .: .: .:
Total Gold produced to 31st December, 1998.	Ore treated. Gold therefrom.	Fine ozs. 230.27 9,151.73 45.19
Total Gold pro Decembe	Ore treated.	Long Tons. 395.00 9,598.00 37.50 
		:::::
Lease,		:::::
any of		:::::
of Comp		
Registered Name of Company of Lease.		Filgrim's Rest Filgrim's Nest Leases Sindry Claims Prince Regent
ů		::::
No. of Lease.		:::
0.		117, 118

1909.	
July,	
to 31st	
Production t	
Total	

177 · 44	:	. 1	9,747.25	-	9,924.69
:	:	:	:	I	:
:	:	:	:		:
:	:	:	:		:
:	:	:	:		:
:	:	:	:		ozs.
:	:	:	:		fine
:	:	:	:		Total fine ozs.
:	:	:	:		
Alluvial	Dollied and Specimens	Ore Treated, Long Tons	Gold therefrom, fine ozs.		

### Weerianna Centre.

In this centre no gold mining has been undertaken for a long time past notwithstanding that the country has good indications for gold-bearing reefs, and that its position in relation to the seaboard enables plant and stores, and mineral produced, to be imported and exported at very low cost. Recently, however, the resumption of work was commenced on the Portaminna Mine, at one time a portion of the property held by the Roebourne Copper and Gold Mines, W.A., N.L., and comprising G.M.Ls. 135, 136, 137, The Portaminna has been taken up by Messrs. Jas. and 138. Redmond and party, who intend to give the lease a good trial. A 10-head battery is on the ground together with a gas-producer plant and other gear. This is now being overhauled and put into working order preparatory to crushing some dumps of low-grade ore on the surface and some which has been left lying in the mine. No work was being done underground, and I was not able to make an inspection. Mr. Redmond informed me that the reef varied from 12 to 14 inches in width, and that he anticipated that it would vield an average value of 7 to 8 dwts. per ton. It is intended also to cyanide the heap of battery sands; these are estimated to be worth 20s. to 21s. per ton.

Table showing the total Gold produced to 31st July, 1909.

No. of Lease.	Registered Name of Company or Lease.	Total Gold to 31st 1	December,	for seven	ld produced months up July, 1909.
		Ore treated.	Gold therefrom.	Ore treated.	Gold therefrom.
143 135, 136, 137, 138	Early Morn Roebourne Copper and Gold Mines of W.A., N.L.	long tons. 11·00 723·00	fine ozs. 3 · 87 273 · 50	tons.	fine ozs.
	Voided Leases Sundry Claims	$\begin{array}{c} 25 \cdot 25 \\ 4 \cdot 00 \end{array}$	$\begin{array}{c} 220 \cdot 30 \\ 25 \cdot 30 \end{array}$		••
	Total	763 · 25	522 · 97		28 · 85

The following table shows the total gold production of the field from the various mining centres up to 31st July, 1909:—

 $763 \cdot 25$ 

 $551 \cdot 82$ 

Total Gold produced to 31st July, 1909-

Ore treated, long tons

Gold therefrom, fine ozs.

### WEST PILBARA GOLDFIELD.

Table showing total Ounces of Gold produced in each Mining Centre up to 31st July, 1909.

						Total	Total produced to 31st December, 1908.	1st December	, 1908.	Total produc	Total produced for seven months up to	onths up to
											orst duny, 1909.	9.
	Mining Centre.	ntre.				Alluvial.	Dollied and Specimens.	Ore treated.	Gold therefrom.	Alluvial.	Ore treated.	Gold therefrom.
				1					i	į	,	į
i						Fine ozs.	Fine ozs.	Long tons.	Fine ozs.	Fine ozs.	Long tons.	Fine ozs.
Croydon	:	:	:	:	:	:	:	8.00	5.44	:	:	:
Hong Kong	:	:	:	:	:	21.40	6:0	340.00	445.60	:	:	:
Lower Nichol	:	:	:	:	:	10.44	3.81	604.10	381.23	:	:	:
Mallina	:	:	:	:	:	:	:	103.60	102.83	:	:	:
Pilbara	:	:	:	:	:	1.11	134.36	148.00	293 · 12	:	:	:
Roebourne	:	:	:	:	:	:	:	:	-:	:	:	39.22
Station Peak	:	:	:	:	:	:	:	10,030.50	9,430.19	177.74	:	317.06
Towranna	:	:	:	:	:	:	:	1,934.80	2,088.26	:	:	:
Weerianna	:	:	:	:	:	:	:	763 - 25	522.97	:	:	28.85
From Goldfields generally, reported by Banks and dealers	lly, report	ted by	Banks	and	Gold-	3,947.37	82.54	:	6.38	263 · 21	:	:
Totals	:	:	:	:	:	3,980 · 32	220.73	13,932.25	13,276 · 32	440 · 95	:	385 · 13

					1		
	:	:		:		:	
	:	:		:		:	
	:	:		:		:	
	:	:		:		ozs.	
	:	:		:		fine	
ļ	:	:		:		Total, fine ozs.	
production to 31st July, 1909	Alitivial	Dollned and Specimens	Off treated, long tons—13,932	croid therefrom, nine ozs.			
Gold							
Otal							

 $\frac{4,421}{220}$ 

13,661

Average yield per ton of ore treated (exclusive of alluvial, dollied and specimens) 0.95.

### COPPER MINING.

The chief copper-producing centre in the West Pilbara Goldfield is Whim Creek. Some of the Croydon mines were being worked by tributers, and some prospecting was being done in the neighbourhood of Roebourne. Elsewhere there was practically nothing doing. I made an inspection of Whim Creek and Roebourne Centres.

### Whim Creek Centre.

The Whim Well Copper Mines, Ltd., Location 71, are owned by a London company of which Mr. H. R. Sleeman is the General Manager in Western Australia. The lode occurs over a large area of country on the eastern slope of a low hill. In past times a good deal of shallow work has been done, and the lode has been opened up and mined at many points along the face of the hill. At the present time the lode is being worked by means of several adits, or tunnels, driven from the side of the hill at different levels. From these the ore is extracted in chambers, or stopes, the backs of which are supported either by pillars of low-grade ore or rock left standing, or by pillars built up of waste rock.

Some of the chambers are of considerable width and height. The management assured me that the backs of these, and of all workings, are regularly and frequently examined and tested for loose ground, and every care exercised to prevent falls of rock. No falls of ground have, so far, occurred. As a rule the back is very strong, but at points where a white kaolinised rock is exposed there is weakness, and care has to be exercised.

Owing to the ore being shipped for treatment, only the highest grade is selected. The medium grade is thrown to one side for treatment at some future time. Whenever possible the medium and low-grade ore is left standing in the mine. This necessity for selection does not enable the ore-breaking and general working of the mine to be carried on as economically or as systematically as would be possible under circumstances where the ore could be locally treated and the low grades dealt with in company with the higher. A small ore-dressing plant, consisting of rock-breaker, grizzlies, and orebins, and sorting floors, is situated alongside the tramway to the sea-port. The best ore is picked by boys and bagged. Thence it is trammed to Balla Balla and lightered out to the steamers. total cost of mining, handling in stopes, trucking, dressing, maintenance, etc., is quoted at 16s. 4.22d. per ton—a very creditable figure in face of the many disadvantages that obtain in connection with mining and handling. Upwards of 100 men and boys are employed in all classes of work. The rate of wage is: hand miners 13s. 4d., shovellers, truckers, and surface labourers 11s. 8d., mechanics 15s. to 16s. 8d., ore sorters (boys) 8s. 4d.; 47 working hours'

week. Board, 25s. per week. The total quantity and value of ore treated to August 31 are 18,290 tons, worth £190,735. Of this, 5,555.00 tons, of the value of £45,032 has been treated during the past eight months of 1909.

The total quantity and value of copper ore obtained from the Whim Creek centre up to August 31, 1909, are 20,329.00 tons to the value of £203,021.

### Roebourne Centre.

Of late years copper mining in this centre has declined very considerably, despite the fact that the lodes have been found to carry good values, and that the mines, being situated near the seaports, are enabled to be worked under the most economic conditions.

At the present time some interesting prospecting is in progress at the old Carlow Castle Mine, now known as the Wait Awhile, and at the Q.E. Mine adjoining. The locality is about six miles south from the town of Roebourne. The prospects in both instances appear to be very favourable, but means of dressing the ore is much needed. Further to the south some good prospects are also being met with.

The Q.E. Mine, G.M.L. 150 (20 acres), is owned by Messrs. Frank Smallpage, Richard O'Brien, and Aldborough J. Davies. The south-easterly boundary adjoins the old Carlow Castle lease. The lode strikes N.N.E. and S.S.W. and dips easterly at about 45deg. At the western side of the lease and towards the southern boundary a shaft has been sunk on the incline of the lode to a depth of 61ft., following a footwall of solid greenstone, probably diorite. From the bottom of the shaft a drive has been extended 15ft. southerly, following the diorite wall, and a crosscut has been driven five feet easterly in lode without meeting with the hanging wall, thus making the total width exposed about 10ft. A vein of black copper ore, varying from two feet to seven feet in width, is being mined, and is estimated to contain 16 to 28 per cent, copper and about 1 30oz. gold per ton. A little native copper shows on the north side of the shaft. The water level of the locality is said to be 80ft, vertical.

The ore is hand-picked, and bagged for exportation to New South Wales, and is purchased by the Melbourne and Great Northern Smelting Co., at Waratah. The following is a copy of sales shown me by Mr. Smallpage:—

134 bags of copper ore Less 3.5 p.c. moisture	4	ewts. 14 3	qrs. 0 1	lbs. 24 5
Net dry weight	4	10	3	19

Spot price of copper, May 3, £57 16s. 3d.

### . Agreed assay, less deductions:—

						£	s.	d.
Copper, 26.5 per cent. tons, 16s. 3d		6 at	£57			69	12	9
Gold, 2·2 ozs., 10·0009 at £4						40		0
Silver, $3 \cdot 0$ ozs., $13 \cdot 6$ at 2s. $\frac{3}{8}$	d.					1	7	7
Ten bags		• •	• •	• •		0	7	6
					£	111	7	10
				£ s.				
Returning charges, 2s. 2d. per				13 2	2			
Rail freight				0 8	-			
Steamer freight				5 18	6			
Traction, 1s. per ton, or part				0 5	0			
Telegrams, etc		• •	••	0 2	0	19	15	8
						10		
Balance		• •	• •	• •	3	E91	12	2
The local costs were:—					£	s.	d.	
Cartage from Mine to Roeb	ourne,	per	ton		0 ]	10	0	
TO 1	••	••		• •	1	2	6	
Total				••	£1	12	_6 6	er ton

This mine appears to be well worth development, and has a prospect of becoming a payable property.

The Wait Awhile Mine, originally known as the Carlow Castle, is a M.L. of 40 acres, held by Shaw, Whitelock, and Bowen. The old workings are full of water, but at a depth of 40ft. the present owners have driven northerly 25ft, along the footwall of the lode; the hanging wall has not been reached. A parcel of from 14 to 15 tons of ore has been shipped to Newcastle, N.S.W., but the smelter returns were not to hand when I was at the mine. The owners valued the ore at 20 per cent. and 20dwt. gold per ton. The total ore produced in this centre up to 31st August, 1909, is 1,343 tons, of the value of £22,685.

A table is attached showing the total ore produced in the various centres of the West Pilbara Goldfield, the aggregate quantity being 22,818.80 tons, of the value of £239,682:—

The total quantity and value of Minerals produced in the West Pilbara Gold-field is—

Gold, from all sources, to 31st July, 1909	 Fine ozs. 18,303 · 45 Tons.	Value, £ 69,668
Copper, to 31st August, 1909	 22,818.80	239,682
Total Value	 	£309,350

### WEST PILBARA GOLDFIELD.

Quantity and Value of Copper Ore produced to 31st August, 1909.

(y. No. of Lease or Claim. 103 Chan. 103 Chan. 103 Chan. 103 Chan. 103 Chan. 103 Chan. 104 Chan. 105 Chan.	Registered Name of Company or Lease.  Evelyn, British Ex. Australasia	Ore. A Constity.  Tons. 15 :00	Metallic Copper.  Tons.	Yalue. £,363 2,75 5,95	Quantity.  Ore.  C C C S 30.00	Metallic Copper. Tons,	Value. \$ 100
103 103 103 103 103 103 103 103 103 103	::::	Ore.  Tons. 519-00 15-00 40-00 12-00	Metallic Copper.  Tons.  4.05	Value. £ 6,363 6,363 595	Ore. Tons.	Metallic Copper. Tons.	Value.
	::::	Tons. 519.00 15.00 40.00	Tons	6,363 2775 2755 2755 2755	Tons. 30.00	Tons.	£ 100
	::::	519·00 15·00 40·00 12·00	4.05	6,363 275 595	30.00	09.0	100
103	:::	15.00 40.00 12.00	4.05	595 595		:	:
91 Eqi 65 Car 65 Car 65 Car	1 Leases	12.00		080	:		
65 Car			- 02.T	7.7	: :	: :	: :
65 Cau	1 Leases	530.00	:	6,571	:	:	:
65 73 E	:		1.00	1000	:	;	:
7.0	Carlow Castle, Roebourne Copper and	81.00	- ss.61	c1#'r	:	:	:
2		6.50	22.	929	:	:	:
118	Era Reward	20.00	2.82	150		•	:
64		10.00	2.50	C\$1	08.0	 06.	10
	Lily Blanche	00.786	180.88	140,11	37.00	8.43	482
F.A. 100	Voided Leases	181.00	::	2.746	:	:	:
Whim Creek 34 Balla Bg	Balla Balla Copper Mines, Ltd	2,000.00	:	12,036	:	:	:
Loc. 71	Whim Well Copper Mines, Ltd	12,735.00	:	145,703	5,555.00	746.50	45,032
Void	Voided Leases	30.00	:	062	:	:	:
	Totals	17,191.50	:	194,017	5,627 · 30	:	45,665

Total Quantity and Value produced to 31st August, 1909.

£ 239,685
:
:
:
Value
:
Tons. 22,818·80
:
:
:
:
Ore

# PILBARA AND WEST PILBARA GOLDFIELDS.

# Table showing the Quantity and Value of all Minerals produced.

							Pilbara Goldfield.	oldfield.	West Pilbar	West Pilbara Goldfield.	Gross	Gross Total.
Mineral	eral.						Quantity.	બ	Quantity.	બ	Quantity.	બ
Gold—From all sources, to 31st July, 1909 Black Tin, to 31st August, 1909 Copper, to 31st August, 1909 Tantalite, to 31st August, 1909 Asbestos, to 31st August, 1909 Total Values	1909 es	: ::::::	: :::::	: :::::	: :::::	: :::::	Fine ozs. 147,802-67 100s67 4,395-44 <i>Nil</i> 86-05 40-00	Fine ozs. 627,825 Toos. 363,211 Nit. 682 11,600 11,600 1,000 4,318	Fine ozs. 18,303 +5 Tons. Nil 22,518 *80 Nil Nil	Fine ozs. 69,668 Tons. Nu. 239,682 Nul Nul Nul	Fine ozs, 166,106-12 Tons, 4,395-44 22,818-80 86-05 40-00	Fine ozs. 697,493 Tons. 363,211 239,682 11,682 1,600 1,313,668

### Conclusion.

The foregoing report deals, with two exceptions, only with places actually visited. There were many others that, in the past, have given good returns in gold, tin, and copper, but as no mining was in progress I did not visit them.

The desertion of a centre does not necessarily indicate, on this field, that it has been worked out, but merely that the existing conditions were not in favour of mining and treating ore of medium and low-grade value. An instance of this may be shown in the tin fields south of Wodgina, where the prospects are really good, but mining is stopped for want of means to treat the ore economically.

Upon the completion of the Port Hedland-Marble Bar railway it is believed that working conditions will be improved to an extent that will encourage miners and capitalists to again work these dormant districts.

In the foregoing table it will be noted that, up to 31st July for gold, and to 31st August for all other minerals, the total value of all minerals produced on the Pilbara field was £1,004,318, and on the West Pilbara field £309,350, or a grand total value of £1,313,668.

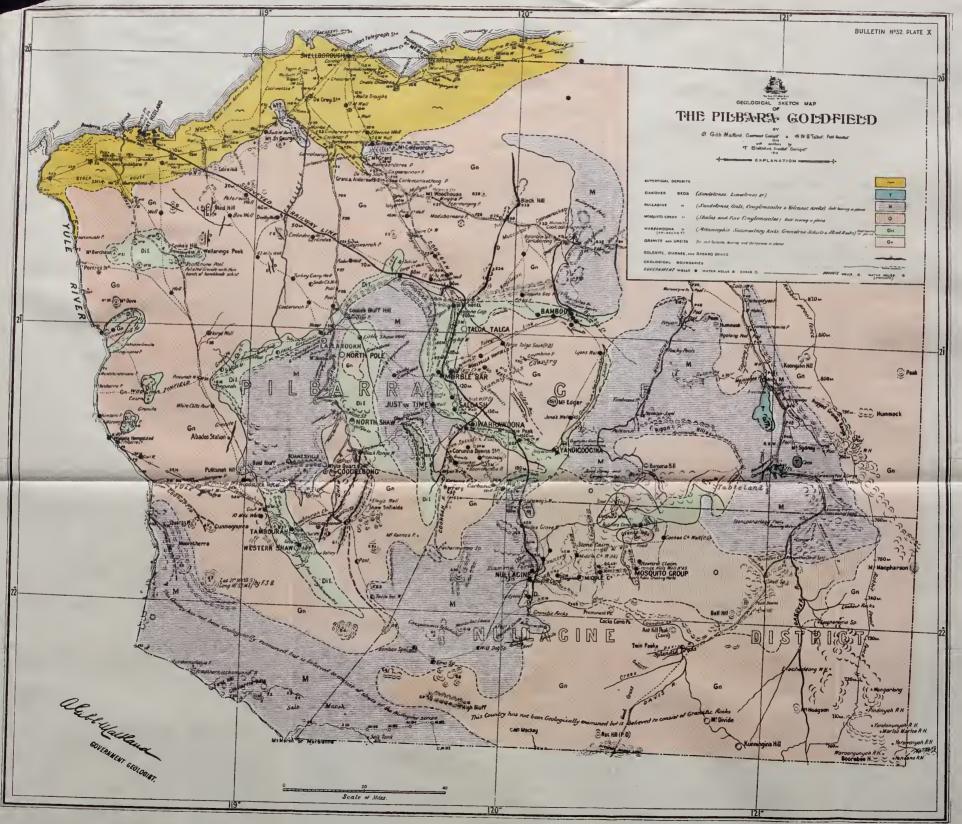
Of the total gold value, the Pilbara field contributed 90.01 per cent., and of the grand total value of all minerals produced 76.46 per cent.

The value of the production is astonishing in view of the comparatively small amount of mining that has been done. It has been said that this can be accounted for on the ground that very rich shoots of ore have been obtained at shallow depths. But, even so, those shoots have been worked only to water level—a shallow depth on these fields—and in few instances has more than one lens of ore been touched in any mine. Consequently, the mines are in no way exhausted, and to resume the rich output from these fields all that is required is further and more systematic development of the mines and economical management.

There can be no doubt as to the great possibilities of the fields, and by the commencement of the railway a good step is being taken in the direction of a revival of mining. It is probable that an extension of the line to other centres beyond Marble Bar will be called for at no distant date and, judging by the prospects shown, the extension will be justified.

At the present time there may not be many discoveries of a size attractive to companies possessed of ample capital for handling large ore-bodies, but there are a large number of mines that would well reward the enterprise of small companies and of parties of working miners. Following upon the efforts of these, the discovery of larger propositions will assuredly come to pass.





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# GEOLOGICAL MAPS, REPORTS, AND BULLETINS

ISSUED BY

# The Geological Survey of Western Australia.

### I. MAPS.

Geological Map of Northampton: by A. Gibb Maitland. Scale, 20 chains per inch. sheets. Price, 2s. 6d.
Geological Map of the North Lead, Kanowna: by Torrington Blatchford. Scale, 8 chains.
1901.

per inch. Price, 1s. 1901.

Geological Map of Kalgoorlie: by A. Gibb Maitland and W. D. Campbell. Scale, 10 chains per inch. Six sheets. Price, 21s. Geological Map of the Boulder Belt and Sheet of Horizontal Sections: by A. Gibb Maitland and W. D. Campbell. Scale, 4 chains per inch. Three sheets. Price, 12s. 6d. 1903.

In preparation:

Geological Sketch Map of Western Australia: by A. Gibb Maitland. Scale, 1/1,584,000. Four sheets.

# II.-REPORTS.

Reports by the Government Geologist in connection with the Water Supply of the Goldfields, containing—(a) Coolgardie and Kalgoorlie; (b.) Mcnzies. (c.) Cuc. Price, 1s. 1897.

Annual Progress Report for the Year 1897. (Out of print.)

1898.

Annual Progress Report for the Year 1898, containing-

Location 1830, Avon District; Gold Discoveries on the Ditchingham Estate, Brunswick River; Collie Coalfield; Proposed Boring for Artesian Water in the Eastern Agricultural Districts; The Country between Cape Richc and Albany; The Wongan Hills; The Artesian Water Prospects of the vicinity of Moora; A Geological Reconnaissance of the Country at the heads of the Murchison and Sandford Rivers, in the Murchison, East Murchison, and Peak Hill Goldfields; Gold Discoveries at Donny-brook; Norseman Public Battery, and the use of Brines in Gold Extraction; Mineral Waters; Mineralogical and Petrological Notes; Kalgoorlie; Menzies. Price, 1s.

Annual Progress Report for the Year 1899, containing—
Notes on the Greenbushes Tinfield; Boring for Water at Mayer's New Find; the Geology of the Bardec District; On the Development of Mining in the locality of Donnybrook; The Geology of the North Lead, Kanowna; The Kanowna Great Boulder, G.M.L. 885x; Mineral Waters; Composition of Native Cold; Greenbushes Tin Ore; Cotalt Ores; Menzies Goldfield; Kalgoorlie Goldfield; Coolgardie Goldfield. Price, 1s. 1900.

Annual Progress Report for the Year 1900, containing-

Inhual Progress Report for the Year 1900, containing—
Kalgoorlie Goldfield; Phillips River Goldfield; Gold Finds on the Preston and Ferguson Rivers; The Present Condition and Future Prospects of the Greenbushes Tinfield; Boring for Coal near Albany; North Lead, Kanowna; Bulong Deep Leads; Coolgardie Deep Leads; Alluvial Deposits, Donnybrook Goldfield; Subsidy to the Norseman Gold Mines, Ltd.; Gascoyne District; Extension of Artesian Watercarrying strata from South Australia. Price, 1s.

1901.

Annual Progress Report for the Year 1901, containing-

Kimberley; Uaroo Find, Ashburton River; Gascoyne; The Island, Lake Austin; Mount Ida; Yardarino Bore; The Dundas Goldfield; The Phillips River Goldfield; Norseman Gold Mines, Ltd.; Allavial Deposits, Siberia. Price, 1s. 1902.

Annual Progress Report for the Year 1902. (Out of print.) 1903.

Annual Progress Report for the Year 1903. (Out of rint.) 1904.

Annual Progress Report for the Year 1904, containing—
Pilbara Goldfield; Notes on a Traverse from Marble Bar to Rocbourne; State Aid
for Boring, Peak Hill; Mount Morgans; The Occurrence of Telluride Ore at Mulgabbic; Southern Cross; Norseman; Reported Tin Find at Cuballing; Reward
Lease at Newcastle, Toodyay District; Boring for Coal, Napier River; Reputed Petroliferous Deposits of the Warren and the Donnelly Rivers; Opal at Coolgardie. Price, 18. 1905

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### Annual Reports-continued.

Annual Progress Report for the Year 1905, containing-

Pilbara Goldfield; Wodgina Tinfield; Mt. Margaret Goldfield; New Find 60 miles E.N.E. of Duketon; Windanya Group of Leases, Broad Arrow Goldfield; Wagin District; Sunbeam Lease, No. 1121x, Kanowna; Northam District; Recent Mining Developments at Greenbushes; Boring for Coal near Mullewa. Price, 1s. 1906.

Annual Progress Report for the Year 1906, eontaining-

State Aid towards the Development of the North End of the Kalgoorlie Goldfield; Mineral Discoveries at Narlarla, West Kimberley District; Cue, Day Dawn, and Cuddingwarra; Barrambie and Errolls; Lawlers, Mount Sir Samuel, Mount Ida, Darlot, and Wilson's Patch; The Saxon Lead Mine, Northampton; Wagin; Arrino and Yandanooka; Clay Deposits of the Clackline District; Beverley District. Price, 1s.

Annual Progress Report for the Year 1907, eontaining-

Artesian Water Boring in the Murehison, Gaseoyne, and Kimberley Districts; The Country between the Gaseoyne and Roebourne; Boring for Coal at Depôt Hill, Irwin Coalfield; Boring for Coal at Eradu, Greenough River; Deep Boring on Fraser's Mine, Southern Cross; Alternative Dam Site at Kelmseott; The Mount Malcolm Copper Mine, Eulaminna; Guano Deposits at Watheroo; Reported Gold Discoveries at Mundijong; Boring for Artesian Water, West Kimberley; Boring near Wyndham; Wolfram and Tin near Brookton; Copper Deposits at Yandanooka. Price, Is. 1908.

Annual Progress Report for the Year 1908. (Out of Print.)

1909.

Annual Progress Report for the Year 1909. (Out of print.)

1910.

Annual Progress Report for the Year 1910, containing-

Results of Boring for Artesian Water on the Eucla Plateau; The Geology of the Country between Sandstone and Lawlers, East Murchison Goldfield, from the point of view of Railway Communication; The Prospects of obtaining a Water Supply for Geraldton, either Artesian, Sub-artesian, Wells or Catehment Areas; The Mount Egerton Diggiags, Peak Hill Goldfield; Report upon the May Queen, G.M.L. 95; Nigarn Goldfield, with regard to the loss of the reef due to faulting; Some notes on the Principal Geological Features of the Kalgoorlie Goldfield; Further Notes on the Gingin Chalk. Price, 1s.

Annual Progress Report for the Year 1911 (Administrative Report only) Price, 1s. 1912.

Annual Progress Report for the Year, 1912, containing-

Water Supply.—Interstate Conference on Artesian Water Supplies: Rottnest Island Bore. Agriculture.—Limestone Deposits of the South-West. Mining etc.—The Country north of Lake Way; The Northern portion of the Kalgoorlie Goldfield; The Country between Kalgoorlie and Coolgardie. Petrological Work.—North Coolgardie and East Murchis on Fields; Kanowna Main Ref Lime; North End. balgoorlie; Ora Banda; Marble Bar; Coolgardie; Mount Imoger and Gibraltar: Binduli, etc.; Southera Cross; Oroya Black Range. Price, 1s. 1913.

# III.-BULLETINS.

- Bibliography of the Geology of Western Australia: by A. Gibb Maitland, Government Geologist. (Out of print.)
- II. The State of Mining in the Kimberley District, and the probability of obtaining Artesian Water between the Pilbara Goldfields and the Great Desert: by R. Neil Smith. (Out of print.) 1898
- II. The Coolgardie Goldfield : by Torrington Blatchford, Assistant Geologist. Price 1s.
- The Mineral Wealth of Western Australia: by A. Gibb Maitland, Government Geologist. (Out of print.)
- v. The Phillips River Mining District; by Torrington Blatchford, Assistant Geologist. (Out of print.) See Bulletin XXXV. 1900.
- Notes from the Departmental Laboratory: by E. S. Simpson, Mineralogist and Assayer. (Out of print.)
- VII. The Auriferous Reefs of Cue and Dav Dawn: by W. D. Campbell, Assistant Geologist. (Out of print.) See Bulletin XXIX. 1903.

- Lennonville, Mount Magnet, and Boogardie, Murchison Goldfield by C. G. Gibson. Assistant Geologist. (Out of print.) 1903.
- The Northampton Mining District: by A. Gibb Maitland, Government Geologist. IX. (Out of Print.) 1903,
  - Paleontological Contributions to the Geology of Western Australia. 1. Carboniferous Fossils from the Gaseoyne District: by R. Etheridge, jun. (Out of print.) X.
- The Country between Edjudina and Yundamindera, North Coolgardie Goldfield: by A. Gibb Maitland, Government Geologist. (Out of print.) 1903.
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- LVI. Country between Kalgoorlie and Coolgardie.
- LVII. Coodardie and Poonah Tinfields.
- LVIII. Artesian Water Resources of W.A.
- LIX. Miscellaneous Reports III.
  - Mining Handbook of Western Australia.

### IV.-MEMOIRS.

### In preparation: -

1. The Geology and Mineral Resources of Western Australia: by A. Gibb Maitland.

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